A UNITED STATES
DEPARTMENT OF
COMMERCE
PUBLICATION

Marine Fisheries
REVIEW

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

San Francisco Bay Area Herring

November 1973
Vol. 35, No. 11
Seattle, WA

Marine Fisheries Review

Vol. 35, No. 11
November 1973

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The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director, Office of Management and Budget, May 10, 1973.

Editor: Thomas A. Manar

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price $1.25 (single copy). Subscription price: $12.50 a year; $15.75 a year for foreign mailing.

MFR PAPER 1014

Cod prices have been rising and will probably continue to rise. The following article tells why.

Why the Cod Shortage? What are the Alternatives?

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INTRODUCTION

In recent years it has become increasingly evident that there is a growing shortage of the traditional species of North Atlantic groundfish and more particularly of cod and haddock. For example, in 1971 the U.S. market experienced a continuing shortage of cod blocks and fillets. Biologists are of the view that it is not possible to increase the landings of cod and other groundfish in the North Atlantic to any significant degree. Therefore, the prospects for supply, both in the short run and in the long run, do not appear to be very encouraging. Demand for cod, however, continues to be strong in all cod markets. During 1970, 1971, and 1972, prices of most groundfish products in the U.S. market underwent a sharp increase. In particular, the price of cod blocks has been on a steady upswing, having nearly tripled since the summer of 1969.

The major questions which emerge are: how can the growing demand of cod blocks and fillets be met and what are the alternative sources of supply for cod?

WORLD LANDINGS OF COD

The overall trend in world cod landings shows an increase of only 1.3 percent per year since 1960 (Figure 1). However, the long-run trend hides two divergent trends. First, the catch from 1960 to its peak in 1968 increased at a rate of 4.1 percent per year.

Since 1968 it has been declining at a rate of 8.3 percent per year (Table 1). Although 1972 data are not available for all countries, the catch was probably a little less than in 1971.

Much of the catch of cod is not available for export to the United States market. Some countries utilize all their landings for their domestic markets. For these countries, rising prices have not caused them to divert cod from their domestic markets to the United States. Several countries, notably Russia, Spain, Portugal, France, and Sweden, take a substantial part of the Atlantic cod, but ship little, if any, to the United States. Their share of the cod catch has been running 30 to 40 percent of the world total. The bottom part of Figure 1 shows the catch from 11 countries which normally ship some cod to the United States plus the U.S. catch. Of the 11, six countries regularly supply over three-fourths of our block imports. Of the total world catch, we have import possibilities for only a little over half of the catch. Note also that the catch in these 11 countries has not risen as fast as the world catch, nor has it dropped as much in recent years. One conclusion that we can draw here is that we have little chance of buying a good part of the world cod catch, even though prices have risen sharply.

Of those 11 countries which normally ship some cod to the United States, let us see how United States consumption has compared with their catches (Figure 2). The cod catch in those

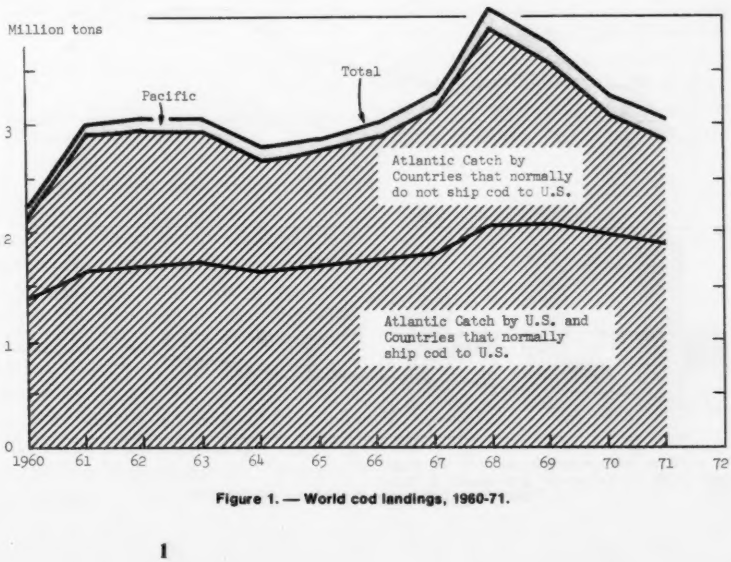

Figure 1. — World cod landings, 1960-71.

Table 1.—World cod landings (1,000 metric tons live weight) for selected years.

Country	1960	1962	1964	1966	1968	1970	1971
				Atlantic Cod			
Canada	274.7	320.6	315.5	306.4	323.1	262.8	244.5
Denmark	58.4	62.9	68.3	89.7	107.4	96.8	133.4
Faroe Is.	84.1	116.3	103.2	90.8	80.9	71.2	61.4
Greenland	28.6	36.3	23.1	30.0	21.3	20.5	19.9
Iceland	243.4	223.4	280.7	231.5	234.6	308.3	255.0
Norway	213.5	296.5	224.6	291.1	388.4	456.6	489.5
Poland	51.1	47.2	53.5	105.8	155.2	126.2	88.1
St. Pierre-Miquelon	4.4	2.9	3.8	4.9	2.2	2.2	1.8
Scotland	41.0	47.6	55.6	55.7	69.1	54.6	57.4
U.K. (Eng & Wales)	273.6	337.9	305.8	331.3	378.4	359.9	309.8
W. Germany	92.2	200.1	176.3	207.9	274.2	190.8	197.6
U.S.A.	18.3	21.3	17.6	17.0	22.3	24.1	24.0
Subtotal	1,383.3	1,713.0	1,628.0	1,762.1	2,057.1	1,974.0	1,882.4
Belgium	9.8	14.8	10.4	20.9	28.1	12.2	23.8
Cuba	—	—	—	1.2	.9	—	—
France	66.2	172.6	164.7	176.4	209.2	140.9	124.3
E. Germany	—	—	45.1	68.9	—	—	34.7
Ireland	1.3	1.0	1.6	2.3	3.5	3.2	4.0
Netherlands	7.2	8.2	11.2	23.7	31.4	25.3	46.9
Portugal	61.7	217.6	227.8	202.3	219.4	198.7	152.7
Romania	—	—	—	—	—	5.0	2.8
Spain	59.8	199.4	221.2	232.7	329.7	268.1	254.9
Sweden	29.4	36.8	25.4	29.3	30.9	22.8	22.0
USSR	531.2	608.5	340.4	357.2	986.3	448.4	283.0
Subtotal	766.6	1,258.9	1,047.8	1,114.9	1,839.4	1,505.4	949.1
TOTAL ATLANTIC	2,149.9	2,971.9	2,675.8	2,877.0	3,896.5	3,098.6	2,831.5
				Pacific Cod			
Canada	2.4	2.0	5.4	10.5	6.2	2.8	4.8
Japan	67.7	76.1	95.3	85.8	109.5	117.1	94.8
Korea	1.8	1.4	1.5	2.2	2.2	2.8	3.1
U.S.A.	2.4	1.4	2.9	4.5	2.7	1.3	2.9
USSR	12.0	9.3	4.9	6.4	22.2	61.6	101.2
TOTAL PACIFIC	86.3	90.2	110.0	110.2	142.8	185.6	206.8
GRAND TOTAL	2,236.2	3,062.1	2,785.8	2,987.2	4,039.3	3,284.2	3,038.3

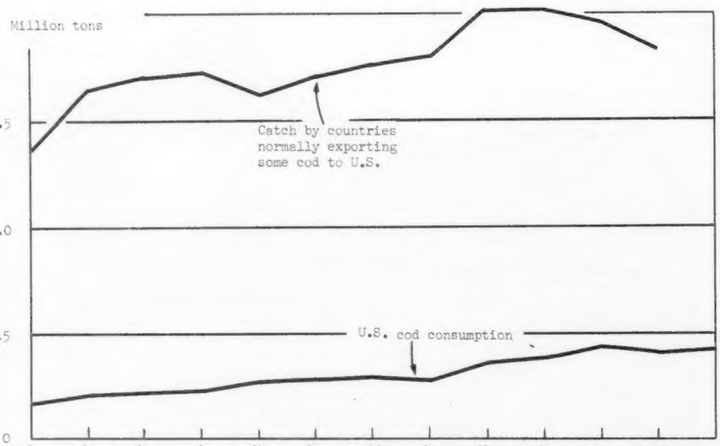

Figure 2. — U.S. share of available cod, 1960-71.

countries shipping to the United States has been increasing by 2.8 percent per year (1960-71).

However, United States cod consumption (fillets and blocks) has been increasing by 8.3 percent per year (1960-72). In 1960, we took 11.9 percent of their catch. By 1971 we took 20.8 percent.

PRICE

What has been the effect on cod prices, given the rise and fall in cod landings? One comparison we can make is between the world catch and the Boston Market News price for cod blocks. As the catch turned up in the mid-1960's, cod block prices dipped in 1966 and 1967 (Figure 3). Prices in 1968 and 1969 held about steady. Since 1969, prices have moved inversely with cod supplies, which is what you would expect. Although the direction in prices was probably no surprise, the magnitude of price increases was fantastic. Since 1968, the world cod supply has dropped 24.8 percent, but the price of cod blocks has nearly tripled. In early June 1973, cod blocks were selling for 65 cents per pound compared with 21 to 22 cents at the same time in 1969.

SUPPLY-DEMAND RELATION

In 1960, the world supply of cod was 13.6 times greater than U.S. consumption. This ratio dropped steadily and by 1966 the world supply was only 8 times greater than our consumption. The figures went up in 1967 and 1968 because of the big jumps in world catches. They have now fallen to the point where in 1971 the world supply was only 7.1 times greater than U.S. consumption.

Now let us look at the same ratios for the top 6 suppliers of cod to the United States. They are Norway, Iceland, Canada, Denmark-Greenland, Poland, and West Germany. In 1960, their catches were nearly 6 times our consumption. The ratio has dropped steadily to the point where, in 1971,

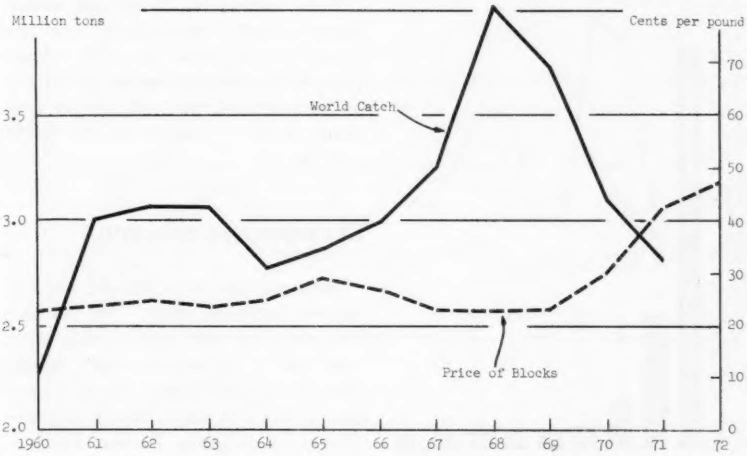

Figure 3.—World catch (1960-71) and price (1960-72) of cod.

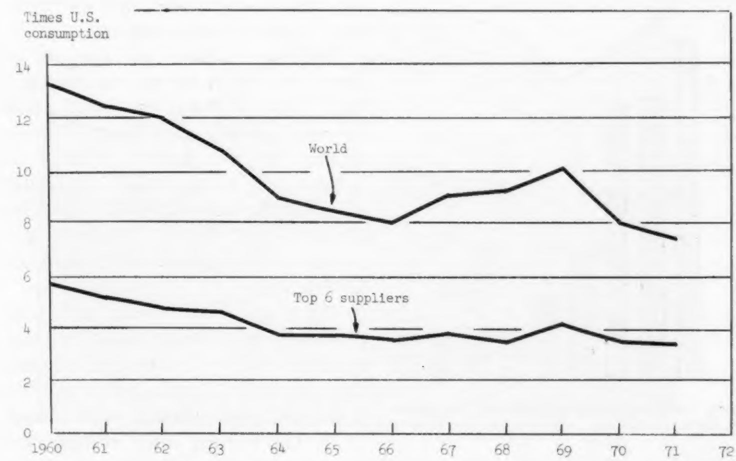

Figure 4.—Ratio of cod supply to U.S. consumption, 1960-71.

If their goal is to produce the right mix of products to maximize returns, this requires the major producers to plan in advance. No later than in December, the major U.S. suppliers should have analyzed the demand for the various cod products in the major consuming nations for the following year. The world cod season is fairly short. By the end of July in Canada, the world cod season is just about over, and cod supplies are relatively fixed for the last half of the year.

WORLD TRADE

Not only is the United States buying more cod, but also the whole world is buying more. Since 1960, the catch of cod has increased 12 percent. But, the world trade in cod, as reported by the Food and Agriculture Organization of the United Nations (FAO), has increased by 53 percent. This would indicate that demand is increasing faster than supply. In economic terms, we would say that demand and supply are in balance. But, they have been coming into balance at higher prices, especially in the last four or five years.

World trade in cod has risen from a third of the catch in 1960 to nearly half in 1970. These statistics come from FAO data.

If you take all the export data and convert it back to the approximate live weight to make it comparable with the catch, you find that trade in dried and salted cod still exceeds that in fresh and frozen cod (Figure 5). The

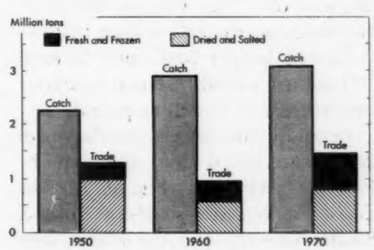

Figure 5.—Cod catch and volume of trade (by types of processing) compared for 1950, 1960, and 1970.

catches by our top suppliers were only 3.5 times our consumption. Our cod consumption is increasing faster than the world catch and much faster than the catch of countries which normally supply us (Figure 4).

Such a supply-demand situation can only lead to one thing—and that is higher prices. Although it appears that the cod catch has leveled off near its maximum sustainable yield, the major producing countries still have great flexibility as to the utilization of cod production. Even if production is relatively stable in the years to come, the major producing countries can increase their cod revenues by continually adjusting their production to the products which they feel will bring the highest prices on the world market. They have four major product categories:

1. Fresh-drawn and fillets.
2. Frozen-fillets and blocks.
3. Drying for stockfish.
4. Salting.

trends appear that this will not be so for very much longer. In 1950, fresh and frozen was about a fourth of the trade. This rose to a third in 1960 and nearly half in 1970. Just in the past decade the trade in cod has gone from 2 to 1 in favor of dried and salted to nearly 50-50. Another point that is interesting to note is the world trade in dried and salted cod. After declining for many years, it has been on the rebound in recent years. In 1950, nearly half of the world catch ended up as exports of dried and salted cod. The trade of dried and salted cod declined during the 1950's, but in the 1960's it started to rise slowly. Trade in dried and salted cod has not been growing as fast as frozen cod in recent years, but the fact that it is higher now than 10 years ago is important. With the relatively fixed supply of cod, every pound that goes for drying or salting is taking away from the frozen trade.

In Norway, 49 percent of the cod catch was frozen in 1970; in 1971 this dropped to 38 percent. Norway salted 23 percent of its cod catch in 1969; 27 percent in 1970; and 40 percent in 1971. The same pattern is evident in Iceland. In 1969, Iceland salted 26 percent of its cod catch; this rose to 28 percent in 1970; and 36 percent in 1971.

Although the United States buys more cod than any other country, it is interesting to see which countries are the principal purchasers of cod—in other words, who are our competitors.

In fresh and frozen cod, we are by far the largest purchasers; however, we take only a little over half of this trade (Figure 6). The United Kingdom purchases nearly 300 million pounds, on a live weight basis, and Sweden 100 million pounds. Several countries import close to 50 million pounds.

Brazil is the largest purchaser of dried and salted cod, followed by Portugal and Italy (Figure 7). The major markets are southern Europe, South America, the Caribbean, and Africa. The surprising thing is that quantities and prices of salted cod to these areas has been increasing in recent years. These are not the most affluent areas of the world, yet they are paying substantial prices for salt cod. The facts are that we are competing with Jamaica, Portugal, Italy, Nigeria, Brazil, and many other countries for the world supply of cod. And our competitors are getting their share.

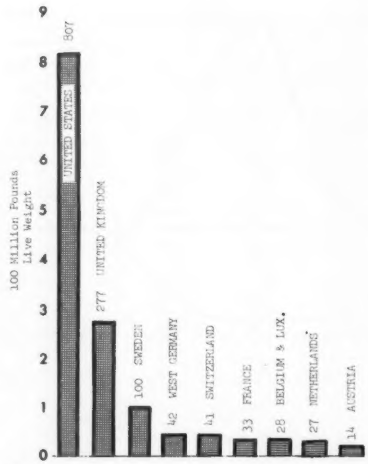

Figure 6.—Major importers of fresh and frozen cod, 1970.

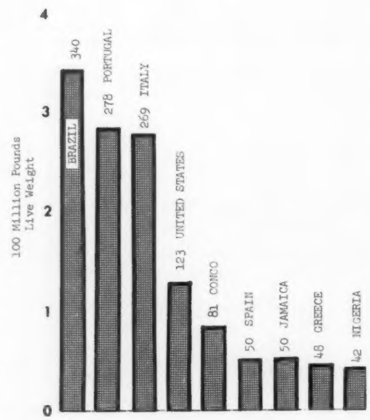

Figure 7.—Major importers of dried and salted cod, 1970.

To summarize this area of catch, trade, and consumption, let us look at the latest available data for 1970. Out of a catch of 3.3 million tons, 44 percent went into foreign trade and 56 percent of the cod was consumed in the country which caught it. Out of the total foreign trade in cod, the United States took 28 percent, which means nearly three-fourths of the trade is with other countries. When you add the United States imports and its catch of cod, this indicates we consume about 13 percent of the world cod catch.

ALTERNATIVE SOURCES

What do we do when we see cod supplies running short? The obvious first step is to seek new sources other than the six countries which supply most of our cod blocks. Recently new suppliers of cod blocks have emerged—Argentina, Belgium, France, Finland, Netherlands, Panama, Romania, and Sweden. Combined, the countries provided only a million pounds—400,000 of which was from Romania. This is not very encouraging.

Can we increase our imports of other groundfish species we normally use? Figure 8 shows the world catch for haddock and ocean perch. Neither species has the growth potential to indicate that we can expect substantial increases in these supplies. It is also doubtful that we will be seeing any substantial increases in world flounder landings.

There are some species that U.S. processors are turning to—whiting and pollock. Figure 9 shows the whiting catch in South Africa and Argentina. It increased substantially in 1970 and 1971. The whiting catch in these two countries is only 6.7 percent of the current world catch of cod.

The species which seems most likely to take up the future slack between the growing demand and stable supply of cod is Alaska pollock caught by Japan. The growth in Japanese Alaska pollock catches has been phenomenal. It is now equivalent to about 80 to 85 percent of the world cod catch. The Japanese Alaska pollock catch, in 1972 was about 2.6 million tons. To put this in perspective, the Japanese catch of this one species—Alaska pollock—was 22 percent greater than the entire United States catch of edible

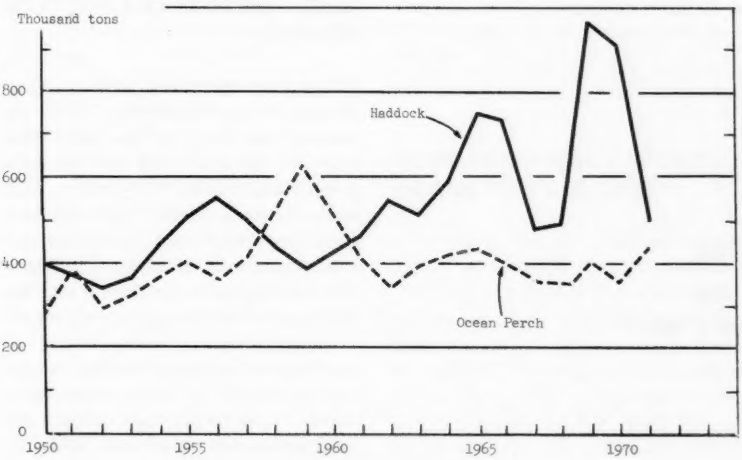

Figure 8. — World catch of haddock and ocean perch, 1950-70.

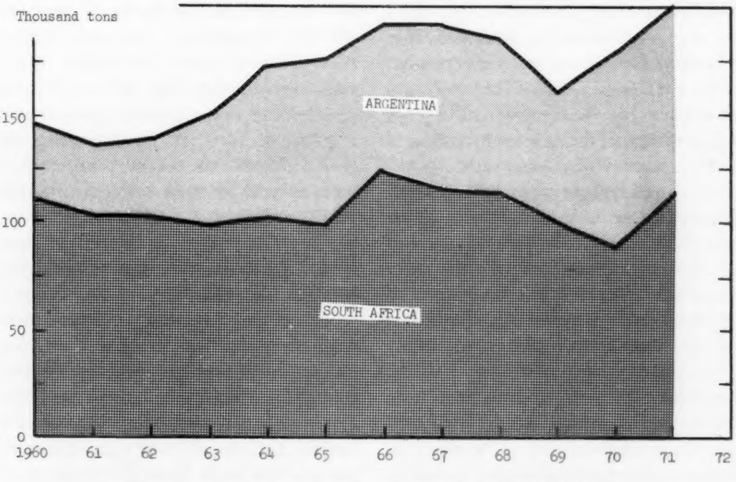

Figure 9. — Whiting catch from Argentina and South Africa, 1960-71.

and industrial fish. The Japanese catch more than half their pollock off Alaska. Their pollock catch in the Bering Sea in 1972 was 1.6 million tons. The entire U.S. catch of edible fish in 1972 was 1.0 million tons. The Japanese normally put about half their Alaska pollock into fish meal and the other half into surimi. In 1971 the Japanese started putting small quantities of Alaska pollock into fish blocks. We received 1.9 million pounds of Alaska pollock blocks from Japan in 1971. Last year pollock blocks from Japan jumped to 32.0 million pounds.

Another alternative is minced blocks which have been available for about 15 years, and most were made into fish cakes or second grade fish sticks. A few years ago better deboning equipment became available and quality has improved somewhat. In the past couple of years, their use has increased substantially. In addition to taking up some of the slack in fillet block supplies, they can also be used when the price of blocks is rising faster than the price of finished products.

CONCLUSION

It is possible to conclude with a relatively optimistic outlook. The transition from cod to pollock is definitely underway as is the growing variety of products coming from minced blocks. This should ease the supply pressure on cod blocks. If the Japanese pollock quality improves, if skinning machines are developed for whiting, and if the quality of minced blocks improves, it is possible that supplies of blocks will be ample for U.S. trade needs for the remainder of the 70's.

The U.S. block market has been expanding by 20 million pounds per year. Pollock, whiting, and minced blocks should be able to meet this rate and even expand it.

MFR Paper 1014, from Marine Fisheries Review, *Vol. 35, No. 11, November, 1973. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, D.C. 20235.*

MFR PAPER 1015

Applying modern methods of mass production to fish culture forms . . .

The Technological Basis for Development of Aquaculture to Produce Low-Cost Food Fish

J.A. DASSOW and M. A. STEINBERG

ABSTRACT

The technological basis for development of large-scale production of inland water fish, such as carp, buffalo fish, tilapia, and white amur, is reviewed. It is proposed that modern methods of mass production and fish culture be evaluated and combined to make the production of low-cost food fish feasible and economically attractive. The fish would be processed for maximum recovery of edible flesh by mechanical methods of flesh separation. The minced flesh would be modified and stabilized as required to prepare high-quality frozen fish blocks. These blocks would be suitable for a wide variety of frozen fishery products and convenience foods and could be used as protein additives in other foods such as processed meats. A conservative yield estimate of 4,000 pounds of fish/acre/year on aquaculture developments totaling 500,000 acres in the delta land of the United States is projected. This could produce 2 billion pounds of landed fish per year in 25 years. Further, this production could supply the additional fish needed to maintain per capita fish consumption in an expanded U.S. population of 300 million.

The technological factors and limitations in this projection are discussed along with the need for research. These factors include: (1) competition for land use, (2) cost of suitable water, (3) increasing costs in a labor-intensive industry, (4) feed cost in relation to product value, (5) disease control, (6) efficient processing techniques, (7) pollution control requirements, and (8) development of markets and consumer acceptance.

INTRODUCTION

It seems clear to almost everybody that sooner or later the increasing population of the United States, together with the gradual rise in the living standard for many underprivileged groups, will greatly expand the demand for protein of all types. One can argue whether a protein shortage may develop in 10, 20, or 50 years, but most food technologists believe this is beside the point. The real question is the need to plan intelligently and do the studies to ensure that in the future the optimum harvest of protein may be obtained from every source—whether it is from plants, animals, or chemical synthesis. The future potential for developing aquaculture as a method to produce low-cost food fish as a major protein contributor is our concern in this report.

NEED FOR FISH AS A PROTEIN SOURCE

Certainly there are many protein sources other than fish that can be expanded; therefore, we first must consider the specific need for fish as a protein source. Its availability, high acceptability in the diet, and high food value are all important. Also important is that fishermen, processors, and buyers make a good living from it and add significantly to the nation's economy.

Traditionally, man has looked on the ocean as an almost endless marine pasture with a common-property fishery resource provided at no cost. All man needed to do was devise the fishing gear, take it to sea, and catch the fish, keeping in mind the seasons and areas of abundance. Certainly it is not that easy any longer. Today the intense competition for every usable food resource from the ocean is not only obvious but also is becoming a problem of international concern and regulation. It is in the knowledge of this problem that we propose a more serious study of the feasibility of large-scale aquaculture. Such a development, in our opinion, would provide in the future that amount of fish for the U.S. diet that will not be available from ocean resources, including that from domestic catches as well as from imports. The current fishery statistics (U.S. Department of Commerce, 1972) show U.S. landings in 1971 of 2.4 billion pounds of fishery products for human food and 1.8 billion pounds of imported edible fishery products. The civilian consumption of edible fishery products produced from this 4.2 billion pounds was 11.2 pounds per

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capita in the United States, a figure that has changed little over the last 25 years.

If we take the current estimate of population growth during the next 25 years, from 200 to 300 million, it's quite obvious that we're going to need over a billion pounds of edible fish products just to fill the gap created by the additional 100 million population, assuming we maintain the present sources of supply. This really means about 2 billion pounds of fish as landed in the United States or the equivalent in imported products will be needed.

Resource experts, of course, have estimated in recent years that the world fisheries harvest can be increased significantly by greater utilization of all available marine resources. Schaefer and Alverson (1968) thought a world fisheries production of 200 million metric tons was realistic. This compares with about 70 million tons at present. Better utilization of available fishery resources is very important. However, our problem as fishery technologists is that we note that U.S. catches have changed little for the past 25 years. Also, we see no indication of overwhelming change in the ability of our fishing fleet to double its production of ocean fish harvest in the next 25 years.

We wonder how many experts would objectively consider the current resource developments and still predict confidently that this increased supply is going to be available to the United States in 2000 from the known ocean resources. There are some who say that world competition for protein sources, the problems of international fisheries management, and the economics of world fisheries make it unlikely that we will be able to maintain our present sources of fish supply, including domestic catches and imports, during the next 25 years.

This perspective suggests that either fish consumption will decrease substantially or else additional resources must be developed. Our belief is that one feasible development to meet this future need for domestic fishery products is the large-scale production of low-cost fish in warm-water pond culture.

CONSIDERATIONS FAVORING INLAND FISH CULTURE

We have referred to inland fish culture, and you are likely wondering "What's the matter with marine species culture for filling this future gap?" One must be impressed by the achievements in marine fish and shellfish culture in the past decade, yet it appears that the developments are primarily in high-value species such as salmon, shrimp, pompano, plaice, tuna, and lobster. For this discussion we will exclude oysters, mussels, and other mollusk culture. Salmon culture has been highly developed in recent years for the purpose of restoring and maintaining the fish stocks. This important aspect of fish culture is also applicable in a lesser degree to other species.

Our objective, however, is further development of aquaculture to increase production of fish for direct consumption. In recent years such a development has occurred in Pacific salmon in Puget Sound. Salmon mariculture techniques are being applied commercially in which coho salmon are raised in salt-water pens to a market size of 8 to 10 oz in less than a year. The dressed fresh and frozen salmon will sell wholesale for over a dollar a pound. There are many problems, of course, of feeding, predation, disease, and maintenance of the marine pens, including pollution and water-quality aspects. However, no one presently expects this to be a means of mass-producing low-cost fish. The outlook is somewhat similar to that developed by the large-scale trout farms in the United States, which concentrate on a highly desirable species to be marketed fresh or frozen with a gourmet image.

Japanese contributions and developments in aquaculture have been substantial for many years, and their culture technology for yellowtail, seabream, shrimp, and other high-value species has been well documented.

Ryther (1968) commented that the Japanese shrimp culture has been perfected to the degree where mass hatchery rearing is carried out routinely. The species was reared to market size and sold for the first net profit in 1967. The quoted market price at that time of $4.00 per pound in Japan for live cultivated shrimp in relation to the relatively low cost of Japanese labor and materials appears out of proportion. However, Ryther indicates that this reflects the effect of the high costs for facilities and feed in shrimp culture.

Let's take another example, yellowtail, from the well-developed aquaculture industry of Japan. Furukawa (1970) showed that the cost of yellowtail culture depends on the methods of culture management, e.g., floating net cage as compared to embanked pond. Feed costs were the biggest single item, however, and varied from 46 to 60 percent of production costs in the three methods of yellowtail culture. Other costs, such as maintenance, wages, and seed varied relatively far more in the various methods. Furukawa concluded that cheap feed of good quality is necessary for successful yellowtail culture in Japan and that the preparation of an artificial diet is desirable to expand the industry.

Other species developments may be cited, but these examples of aquaculture for high-value species illustrate that problems in marketing, technology, and management limit the industrial development after the biological success of seeding and reproduction techniques is assured. Second, it appears that selection of a high-value species with the gourmet image does not assure instant industry success and profits.

Third, it appears that feed costs and feeding technology are high-cost factors that must be studied comprehensively and solved within the economic limits of a particular species. With these points in mind we can turn

to a closer examination of the technological basis for production of low-cost food fish by aquaculture.

Production of Low-Cost Food Fish

The feasibility and economics of freshwater aquaculture to provide fish on a substantial national level must be demonstrated on its potential for large-scale production of suitable food species at low cost. Otherwise, aquaculture will provide no more than an additional source of high-priced fish to provide variety for the American gourmet. This is desirable but will not help provide much of the 2 billion pounds of additional fish needed in 2000. To accomplish this with aquaculture we suggest the technological development of warm-water inland fish culture utilizing species that will produce the maximum protein return per acre per year.

The fish species proposed for expanded production study are those for which we already have from fish culturists some firm indication of a high production potential. Species will be selected for maximum productivity and desirable growth characteristics under warm-water conditions and might include carp, buffalo fish, tilapia, white amur or grass carp, mullet, milkfish, and catfish. Selective breeding of adaptable species for maximum growth return in large-scale inland water impoundments is an essential part of the development, just as it has been for poultry and livestock.

It is well established in fish culture that the highest production may be obtained by use of species having the shortest food chain; therefore, plankton-feeders like tilapia and herbivorous species such as white amur will win the production race against insectivorous fish like channel catfish. Swingle (1968) of the Auburn University Experiment Station, Auburn, Alabama, reported in 1966 to the FAO Symposium on Warm-Water Pond Fish Culture that species combinations are highly useful and productive in pond-fish culture. This polyculture means, for example, combining plankton feeders like tilapia with insectivorous fish like catfish and piscivorous fish such as large-mouth bass. Dr. E. W. Shell, also of the Auburn University Station, has provided information (personal communication, August 1972) that carp and buffalo fish may be raised to commercial size in either one or two years, depending on the market size required. The yield per year is about the same, 2,000 pounds per acre. An increase of this yield to 3,000 to 4,000 pounds per acre per year is forecast with improvements in culture methods.

Even more promising from a production viewpoint is the white amur or grass carp. This herbivorous species may be started in the pond as fry and will produce more than 4,000 pounds per acre per year. If culture facilities permit the introduction of 3-inch fingerlings, two-pound white amur may be harvested in three months and three crops a year could be harvested for a total of 8,000 to 12,000 pounds of yield per acre per year. As an indication of production cost, the fish culturists at Auburn University (Dr. E. W. Shell) and the Bureau of Sport Fisheries and Wildlife Station at Stuttgart, Arkansas, state that buffalo fish can be raised for 12 to 14 cents a pound with the present knowledge in fish culture. Faster-growing species, such as the white amur, can probably be raised even more cheaply, given the technological production facilities. Use of polyculture and control of water temperature for optimum growth the year around are other likely methods for decreasing production cost. More examples of production potential might be cited; however, we think these illustrate the real possibilities ahead for inland fish culture.

Space is another factor for aquaculture but offers no real problem. In the Pacific Northwest, especially in the Columbia Basin, there is substantial acreage of undeveloped land which is either not suitable for irrigated crop development or is not attractive economically for agricultural development. Greenwood (1971) stated in a review of inland fisheries that over 2 million acres of delta land in the United States are apparently available and acceptable for aquaculture development. If one assumes development in the next 25 years on only one-fourth of this delta land with a production of 4,000 pounds of fish per acre per year, we would have 2 billion pounds of landed fish produced just from the southeastern part of the United States.

Utilizing Pond-Fish For Food

The U.S. consumer has shown generally a preference for marine species and for cold-water, freshwater fish like trout and whitefish. With the exception of cultured catfish in recent years, these preferences have inhibited the development of inland fisheries and pond-fish culture. The question then is how does the technologist propose to use these large volumes of cultured pond fish for food in view of the fact that they are not well accepted. Briefly, the answer is to use them for processed products in which species is not important but convenience, food value, and acceptability of the finished products are important.

Recent developments in the field of fish-processing technology make it practicable to use a wide variety of species not accepted as prime food fish. Methods are now available for the production of high-quality fish blocks (Figure 1) from the mechanically separated minced flesh (Figure 2) of either single species or of combinations of species. During the 1950's the development and wide acceptance by the consumer of fishsticks, breaded fish portions, and other heat-and-eat convenience foods created a substantial national market for frozen cod and haddock fillet blocks. As the demand increased during the 1960's, the processors became increasingly dependent on imported cod blocks (Figure 3).

Figure 1.—A National Marine Fisheries Service scientist in Seattle examines a flavor- and texture-modified plate-frozen fish block produced from hake, one of our underutilized species. The minced flesh for this block was obtained by passing headed and gutted hake through a flesh-separator machine, at about half the cost of conventional fillets.

Predictably, the average price rose sharply (Figure 4). As supplies of domestic and imported cod and haddock became too limited to meet the demand, processors turned to less-desirable species still suitable for blocks, such as Pacific pollock, Greenland turbot, ocean perch, and wolffish. In December 1971 frozen blocks of these and other miscellaneous species accounted for 43 percent of the available supply.

In the past four years our laboratory has made large gains in developing the technology of separating edible flesh from skin and bones in high yield by mechanical methods. Yields can now be increased from present hand- or machine-filleting 30-33 percent to machine separation of 45-65 percent. This can be directly applied to economical preparation of frozen blocks of the minced flesh from cultured species of warm-water pond fish. Most important for application to many less-desirable species, the method lends itself to flavor and texture control and to improved stabilization of product during frozen storage (Teeny and Miyauchi, 1972).

We have demonstrated that blocks made from the comminuted flesh of buffalo fish and of carp are of high acceptability and have good processing characteristics. Considerable enthusiasm has been shown on the part of processors in inland areas, where wild buffalo fish, carp, and other warm-water species are relatively abundant. It is obvious, however, to even the most optimistic processor of

Figure 2.—Technologists at the National Marine Fisheries Service Fishery Products Technology Center in Seattle are preparing minced flesh from dressed fish by use of a Japanese flesh-separator machine. The work is part of research in developing new ways of recovering and using all the edible portion from underutilized fish species.

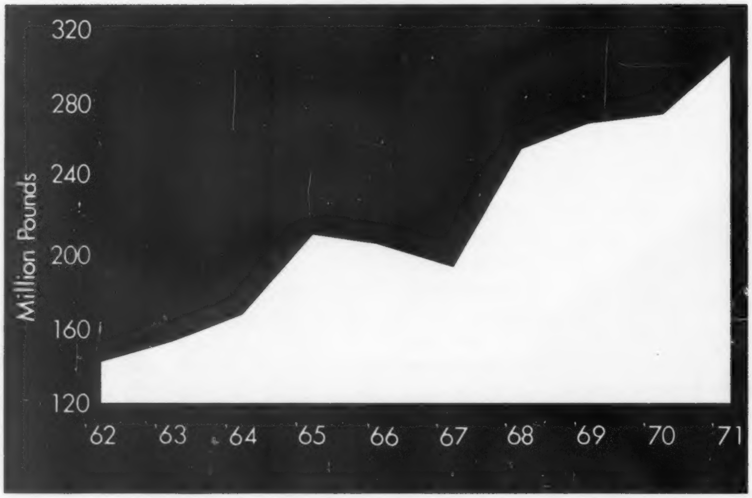

Figure 3.—U.S. imports of fish blocks (1962-71).

these species, that a commercial operation of major proportions would quickly reduce wild stocks to uneconomic levels. The processor of fish sticks and portions must have a large and reliable supply of low-cost raw materials. This could be provided by large, industrial aquaculture operations. The concept of culturing relatively low-value species is a departure from previously held views in which only high-value carnivores were considered to be suitable subjects for aquaculture. The production of warm-water, fresh-water herbivores, whose nutritional requirements are met by supplemental feeding, seems to be an entirely realistic and economically feasible operation, provided it is geared to the needs of the processor and the institutional market. It has the potential for freeing the U.S. processor from dependence on the increasingly expensive and continually decreasing supply of imported groundfish.

TECHNOLOGICAL FACTORS IN PRODUCTION OF LOW-COST POND FISH

At this point we would like to summarize our position with a quotation from the chapter "Fish for 300 Million" by Philip M. Roedel (1971) in the book "Our Changing Fisheries."

"The potential for artificial cultivation is many, many times the present production from aquaculture, and scientific research and application of modern engineering techniques could result in many practical advances. Commercial firms are showing considerable interest in certain aspects of aquaculture because of the resource ownership aspects and the ability to employ advanced production systems that will provide a uniform supply to meet market demand. Today, artificial cultivation in fisheries can be likened to the poultry industry of 25 years ago, when production of broiler chickens was about 9 percent of what it was in 1968. Aquaculture has the potential to match the tremendous growth exhibited in the poultry industry."

The comparison with the development of the mass production poultry industry is most appropriate to us. We believe that the technological factors and limitations that are important to large-scale production of food fish by pond culture have much similarity to the problems faced by the poultry industry 25 years ago. Foremost among these limitations are: (1) competition for land use, (2) cost of suit-

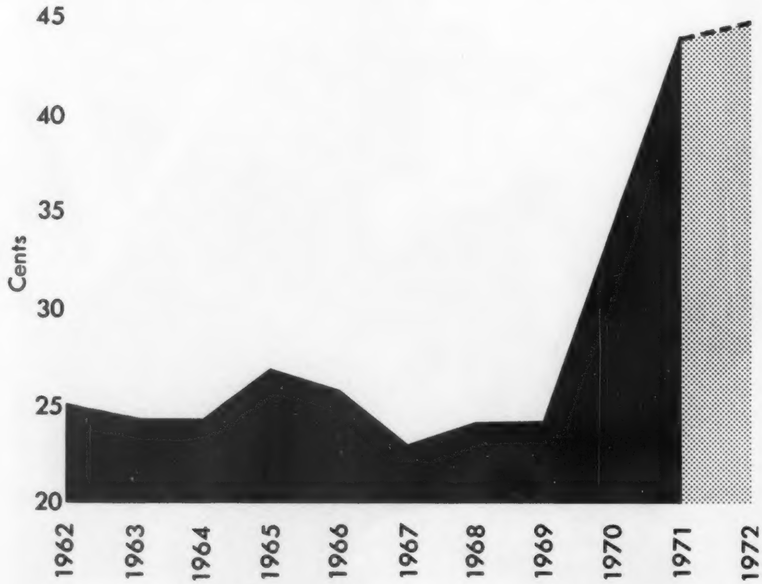

Figure 4.—Average price of cod blocks to U.S. fish processors (1962-72).

able water, (3) increasing costs in a labor-intensive industry, (4) feed cost in relation to product value, (5) disease control, (6) efficient processing techniques, (7) pollution-control requirements, and (8) development of markets and consumer acceptance.

In our comparison with the poultry industry of 25 years ago, however, the last two items, pollution control and marketing, were probably the least of the problems faced by the poultry producers in the 1940's and 1950's. Both of these items will assume major roles in the development of large-scale aquaculture. We have not mentioned the problem of securing risk capital for development of aquaculture simply because, if we can solve the technological limitations, the desirability of aquaculture as an investment will be established. In discussing these limitations, as follows, only the extent of the problem and the contribution toward solution that can be made by technological research are indicated.

Competition for Land Use

The pertinent question that must be answered is whether the value of the crop produced exceeds the value of competing uses. In 1971 U.S. processors spent about 137 million dollars for imported fish blocks. This cost will increase as the ocean resource declines and international competition increases for the available resource. Costs will also increase with the general trend of things. Of course, this last point applies to the culture of pond fish, but we suggest that production costs will decrease as knowledge is gained on methods for increasing efficiency through culture techniques, selective breeding, nutrition, improved feeds, and technological improvements. An aquaculture operation such as we are concerned with can absorb increasing land and water costs better than the marine fishery can absorb the costs of lowered yield per unit of effort. As for competing uses, we suspect that mariculture operations in sheltered coastal waters would experience more competition from recreational and commercial users than would fresh-water aquaculture operations in rural areas. Most agricultural operations would not be competitive because the land used for aquaculture will be of marginal value for agriculture and, in any case, the production and value of fish per acre will be justified as is any other return on the land.

Cost of Suitable Water

The water quality requirements for warm-water-pond fish must be defined on the basis of species requirements, although generally the water must meet accepted chemical and biological criteria now defined by the states in their water-quality standards. In future developments, the use of waste-cooling water or thermal effluents from steam-electric and nuclear-power plants has already been forecast by the work of National Marine Fisheries Service and other agencies (Yee, 1972; McNeil, 1970). This heated water will be used to maintain the optimum temperature for fish culture year around. Use of warm water from geothermal sources and developments is also likely. In the future but arriving very fast is the development of practicable water-treatment methodology to enable a fish hatchery or culture facility to treat and recycle the water. Such recirculation would appear to be particularly desirable for the raceway culture of food fish predicted for the future. With these developments, it is believed that water costs will be reasonable for large-scale fish culture. Some problems for research include the effect on the fish of buildup of trace elements and organic contaminants, if not removed in the treatment process. Use of chlorination and ozonation to purify natural or waste waters has definite limitations for later use in trout and minnow culture (Basch et al., 1971). Additional research on disinfection methodology is needed, including these and other treatments such as ultraviolet disinfection. However, there appear to be no severe limiting factors in the present technology and the known effects on the fish species studied to date.

Figure 5.—Large-scale trout production ponds near Buhl, Idaho. The tall metal silos are for dry feed storage and supply the feed lines to the automatic feed dispensers in each raceway.

Increasing Costs In A Labor-Intensive Industry

Anyone who has worked in or been around a fish-cultural facility knows the meaning of labor intensive. It seems as if everything to be fed, moved, or transferred involves a great amount of manual labor. Obviously, there is an answer through production design and mechanization but, in our judgment, only if the fish-culture production facility is large and planned for efficiency and mechanization. Such a facility will be as different from a conventional fish hatchery or trout farm as a modern battery-cage broiler-production plant is different from the poultry farm of 1940. Automated feeding methods are entirely feasible for many fish species (Figure 5). In at least one species, *Tilapia aurea*, the use of cage culture has been demonstrated for controlling reproduction in ponds used for intensive production of marketable fish (Pagan, 1969). Mechanized harvesting of fish of a desired size would be most practicable in a cage or raceway-type culture. Selection and adaptation of species and, indeed, the breeding and genetic development of adaptable species are forecast. This will require many years because, as pointed out by Simon (1970) in his research at Oregon State University, it is more effective to select a single population for changing one characteristic than to attempt simultaneous selection for several desirable characteristics. The selection and breeding of fish for inland waters having the necessary characteristics for production in a mechanized facility are essential to the solution of this problem of high labor costs in aquaculture.

Feed Cost

Feed is the highest single cost factor in raising fish to marketable size. The biologist is concerned primarily with feed conversion, the weight of feed needed to produce one pound of marketable fish. As indicated earlier, the feasibility of salmon mariculture in Puget Sound has been demonstrated by National Marine Fisheries Service researchers. In December 1970 the researchers reported that with a conversion of 1.5 and feed at 16.5 cents per pound (Oregon Moist Pellets), it would cost about 25 cents for the feed to produce 1 pound of coho salmon (Mahnken et al., 1970). The salmon would be harvested at the optimum size, about 10 to 12 ounces, for maximum conversion. Fish can be held longer to produce larger sizes, but this results in a significantly greater conversion figure of feed per pound of fish harvested. Costs per pound of product would be naturally higher. All this, of course, is similar to what went on years ago in the broiler chicken industry. The same approach is being applied in catfish farming currently and must be applied to make commercial culture of any species successful.

The important thing to emphasize is that the development of the most efficient and lowest cost feed (as in the Oregon moist pellet for salmon) is a research job for the nutritionist and the food technologist in cooperation with the fish culturist. Recent cooperative tests by our laboratory with Dr. Lauren R. Donaldson at the University of Washington College of Fisheries demonstrated the value and possible use of pelagic red crab (*Pleuroncodes planipes*) in feeds for trout and salmon. This red crab is a small crustacean occurring in huge quantities in the southeastern Pacific and off both coasts of Baja California. The crab provides a good protein source and is exceptionally rich in carotenoids that are a desirable component for improving the color and acceptability of the fish. A study (Steel, 1971) at Oregon State University demonstrated that a trout diet rich in carotenoids also produces fish with a better flavor. More collaborative studies between the food technologist and the fish culturist are needed to make the best use of low-cost feed materials and to formulate the most efficient diet. Just as in other animals, it is essential to study each species' requirements in the culture environment. In this way technology can contribute to better utilization of our little-used fishery resources for foods and to production of lower-cost feeds for large-scale aquaculture.

Disease Control

The problem of disease control is not just up to the fish culturist or the pathologist in this greater perspective of modern aquaculture. Development and formulation of feeds, effects of trace elements and growth factors, control of water quality and temperature, and influence of other environmental factors such as tank, pond, or cage design are all important. The NMFS biologists working with salmon culture in Puget Sound found, e.g., that the infection of the salmon with *Vibrio* was related in part to design of the pens, the web used, and problems of fouling, and the need for rapid flushing by tidal currents.

Efficient Processing Techniques

The inefficient and unsanitary methods of harvesting and processing trout, buffalo fish, and catfish from simple farm ponds are not acceptable for modern aquaculture. Industry leaders in trout farming and most recently in salmon mariculture are interested in better methods of harvesting, killing, bleeding, butchering, processing, and packaging the fish. The use of cold-brine immersion for stunning and immobilizing the fish just out of the water has been an important step forward. Studies in our laboratory show that killing and bleeding techniques affect the color, quality, and even the cold storage life of dressed trout or salmon. We expect that these factors will be important in harvesting and processing mass-produced, inland-water species for both the mar-

keted fresh fish and those processed to frozen blocks and a variety of fishery products.

The species selected for high yield and growth potential in inland waters will probably include fish such as carp, tilapia, buffalo fish, amur, mullet, and others that are not highly desirable as dressed pan fish. The processing of these species will consist of heading and gutting, separation of all edible flesh by machine, and the processing of the edible flesh to frozen blocks. The blocks form the intermediate material for processing at the wholesale level to fish portions, sticks, sandwich portions, fish cakes, spreads, specialty products, and as a wet-protein ingredient in processed meats and foods of many types. Much of the basic technological study has been done for this development by the NMFS technological centers in Seattle and Gloucester, Massachusetts. This proposal for the future use of cultured inland fish simply brings together the potential yield from large-scale production with a process technology capable of utilizing it in the most efficient manner for a wide variety of convenience foods.

Pollution Control Requirements

Little need be said on the importance of planning and research on pollution control in any large-scale aquaculture enterprise. If the concept of a large-scale culture facility is integrated with the processing facility, it is desirable to plan pollution control on a unified basis. For example, waste materials and protein from the food-processing plant become part of the raw materials for feed formulation, thereby closing the cycle for solid waste utilization. Plant effluents could be treated for recovery of dissolved proteins for feed materials, thereby lightening the pollution load. If plans call for secondary and tertiary treatment of all effluents, the complete technology of water treatment and reuse may be applied for both culture and process facilities.

Development of Markets And Consumer Acceptance

We do not underestimate the problem of marketing fish and fishery products with unfamiliar names, or worse, with names linked to strong prejudices. Those who have worked with marketing of buffalo fish and carp are familiar with this problem. A good product image and consumer acceptance will be difficult or impossible to achieve in our opinion within inland fish products unless the food industry approaches the problem of selling these new species and products to the American consumer in the same spirit used with every other new food concept. You will note that we said food industry, *not* fishery industry, for the obvious reason that the first element of success in this projection of an industry for large-scale production of inland fish will be to recognize that the producer is in the food business first and the fish business second. The government market specialists and technologists will be needed to assist industry in the developing years; however, the main solution to the marketing problem will lie with American food industry know-how.

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MFR PAPER 1016

An ocean-going marine fish hatchery outfitted for general scientific research — that was the . . .

Fisheries Research Steamer *Fish Hawk*

JOHN W. REINTJES

The U.S. Commission of Fish and Fisheries recognized the need for coastal vessels to conduct surveys, explorations and scientific research on marine resources from its beginning by a joint resolution of Congress on February 9, 1871. In 1879 Congress appropriated $45,000 for a vessel and the Commission decided on a coastal steamer designed by C. W. Copeland of the Light House Board. It was planned primarily as a floating hatchery and was to be named the *Fish Hawk*.

Until 1880 the Navy Department had furnished steamers for the Commission's summer work every year except 1872 and 1876. The first detail was a small steam launch in 1871. In 1873, 1874, and 1875 the 100-ton steamer *Blue Light* and in 1877, 1878 and 1879 the 306-ton steamer *Speedwell* provided excellent facilities for coastal surveys.

A FLOATING HATCHERY

The *Fish Hawk*, a coal burning twin-screw steamer, was 157 feet long with 484 tons displacement (Figure 1). The fore and aft two-masted schooner was commissioned in the spring of 1880 and the Navy Department provided officers and crew under the command of Lieut. Z. L. Tanner. She was outfitted as a hatchery for shad, striped bass, mackerel and herring and also for general scientific research with a hoisting winch with 1,000 fathoms of steel cable (Figure 2) for trawling and dredging and a variety of other equipment for sounding, obtaining sea bottom temperatures and collecting marine organisms.

The hull below the main deck was of iron sheathed with yellow pine, about 3-inches thick, caulked and coppered. Above the main deck the structure was wood. She had a promenade deck extending from stem to stern and from side to side on which

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Figure 1.—The fisheries steamer *Fish Hawk*.

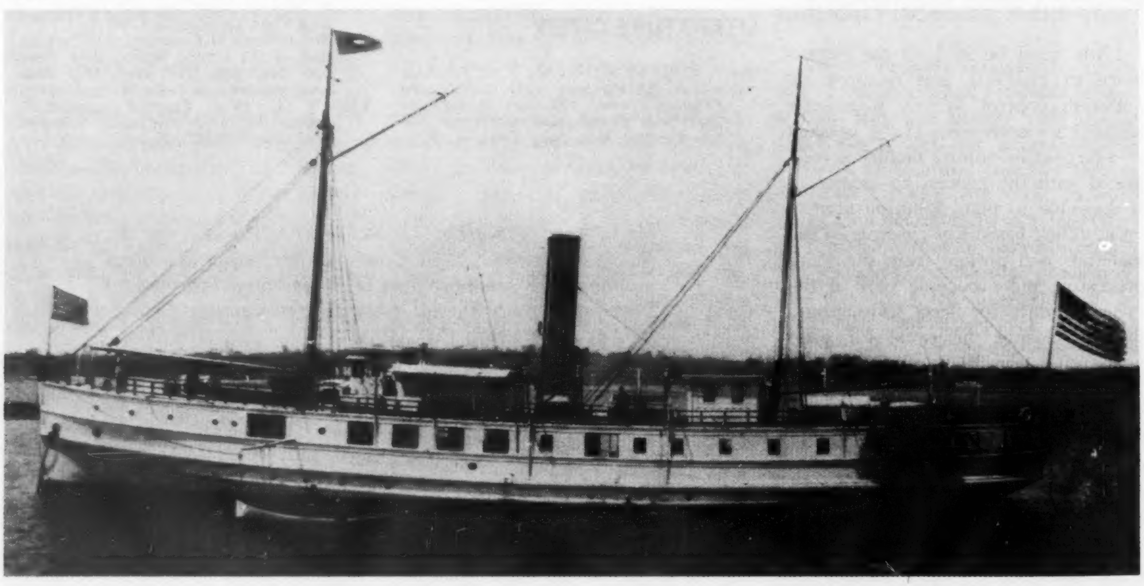


Figure 2.—Hoisting winch with 1,000 fathoms of steel cable.

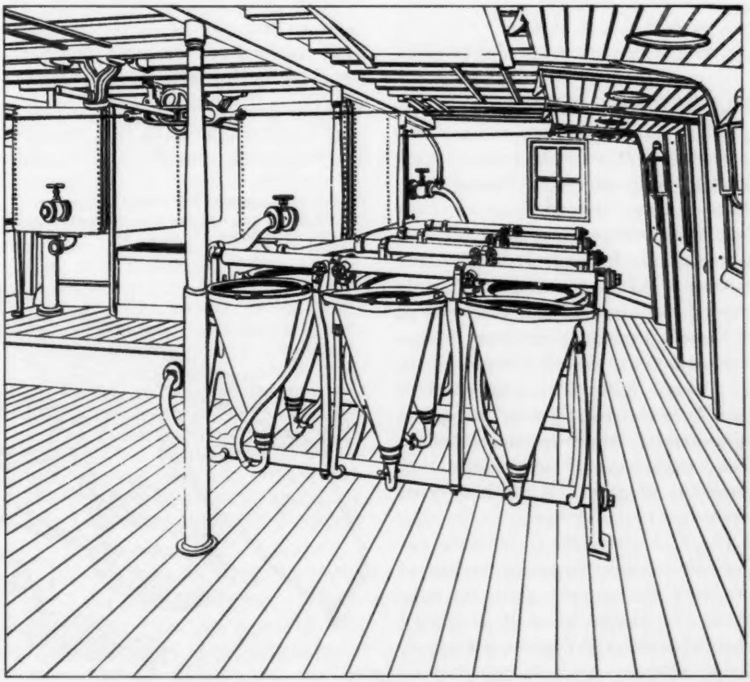


Figure 3.—Main deck showing some of the hatching cones and the two 500-gallon distribution tanks.

was located the pilot house, captain's quarters and laboratory.

In 1870, most fishery scientists believed that spawning success was the most significant factor in the productivity of fisheries. American shad was one of the more important fisheries of the United States and their propagation had the highest priority. To successfully propagate shad, hatcheries would have to be built on every major river from Florida to Massachusetts. Because shad runs last only a month or less at any locality, the concept of a floating hatchery that could move along the coast was considered practical.

HATCHING EQUIPMENT

The main deck was filled with hatching equipment (Figure 3). This equipment consisted of a pump supplying 10,000 gallons per hour, two distribution tanks of 500 gallons each, 36 hatching cones, each capable of hatching 200,000 shad eggs, and 18 hatching cylinders, which were suspended nine on each side from beams outside the vessel (Figure 4). Fertilized eggs were placed in each cone and the current was regulated by feed valves to keep them gently in motion so they would not mat or settle to the bottom. The hatching cylinders with wire gauze bottoms were suspended, partially submerged, over the side and cam machinery gave them a gentle ascent and a more rapid descent of about 8 inches causing the eggs to rise from the bottom and circulate freely. Each cylinder held about 250,000 eggs.

The trawling, dredging and collecting gear consisted of an otter trawl and three beam trawls, 9, 11 and 17 feet, Blake and Chester rake dredges and a tangle bar (Figures 5 and 6). The tangle bar was an iron axle and wheels with deck swabs or bundles of rope yarn on chains that were

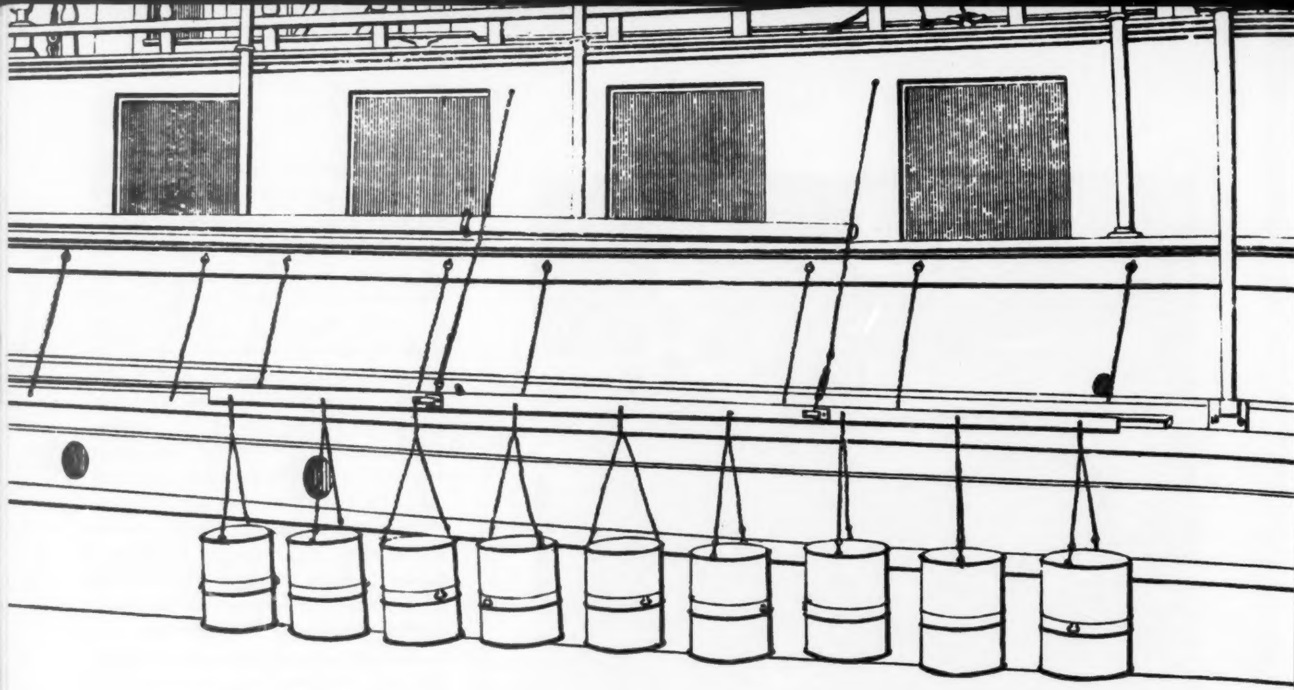


Figure 4.—Hatching cylinders suspended over the *Fish Hawk's* port side.

dragged along the rocky bottom to capture marine organisms.

Hydrographic equipment consisted of a sounding machine with 600 fathoms of piano wire, deep-sea reversing thermometers and density salinometers.

TILEFISH DISCOVERY

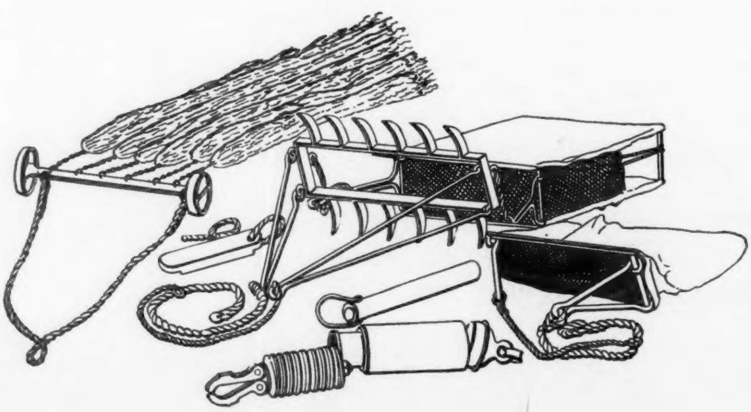
The *Fish Hawk* was designed as a hatchery ship capable of going nearshore in bays and estuaries and was not considered too suitable for offshore oceanic research. However, during her 46 years of active service she trawled and dredged out to the edge of the Continental Shelf from Maine to Florida, in the Gulf of Mexico, and off Puerto Rico. The objectives of trawling and dredging were to explore for potential fishery resources and to collect organisms for more information about the identity and life history of marine animals and plants.

The *Fish Hawk* began her long career with the auspicious and publicized discovery of the tilefish along the edge of the Continental Shelf. It all started when a commercial fisherman, Captain Kirby, brought some strange fish to the Fish Commission's station at Gloucester, Mass., in 1879. It was a new fish, new to science and new to the fishing industry. The *Fish Hawk* was called upon to explore the possibilities of this new resource. Four trips were made to the edge of the Shelf in 1880 and 40 new species of molluscs and 20 new species of fishes were obtained but the most important observations in this offshore region were those made on the tilefish.

The known range of this valuable fish was greatly extended and its existence in fishable quantities was established. The *Fish Hawk* made nine trips in 1881 and tilefish were found along the edge of the Shelf as far south as Delaware and in numbers equal to cod on the northern banks.

In 1882 a catastrophe overtook the promising tilefish resource only 3 years after its discovery. The first news of the disaster came in March. By the end of April scores of vessels had reported sighting dead tilefish for an estimated total of a billion and a half dead fish. The destruction of the tilefish was so nearly complete that fishing trials carried off southern New

Figure 5.—Assorted collecting equipment including Blake and Chester rake dredges, dredge weights, water bottle, and tangle bar.



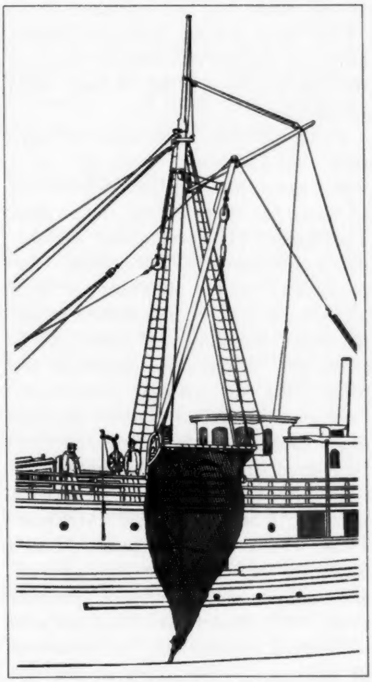


Figure 6.—11-foot beam trawl ready for lowering.

England by the Fish Commission later in 1882, 1883, 1884, 1885, 1886 and 1887 did not yield a single fish. In 1884 the search was especially diligent and thorough.

But the species was not quite extinct. The *Grampus* caught eight off Martha's Vineyard in 1892 and 53 in 1893. By 1915 tilefish were numerous enough so the Bureau of Fisheries undertook to publicize its abundance and to encourage market acceptance. Landings exceeded 10 million pounds in 1916 but the market demand did not continue. Since then landings have ranged from several hundred thousand to 2 million pounds annually.

From 1880 to 1898, the *Fish Hawk* served as a hatchery for shad every spring and during other times of the year for oyster, lobster, mackerel and several other fishes. In 1898 the usual fish cultural assignment was taken up in North Carolina and in the Delaware River until May 4 when, by order of the President, she was turned over to the Navy Department for several months service in the Mosquito Fleet during the Spanish-American War.

The *Fish Hawk* was the principal fishery vessel for the commission and its successor, the Bureau of Fisheries, along the Atlantic and Gulf coasts until 1926. Her activities were extremely varied, for besides serving as a hatchery, she conducted surveys of oyster, sponge and fishing grounds, and she transported materials and supplies for the construction and maintenance of fishery stations. Expositions were relatively popular at the turn of the century and the *Fish Hawk* was open to public display at many of them. Some of the larger ones were the Tampa Fishing Congress (1897-1898), Charleston Exposition (1902) and Jamestown Exposition (1907).

An excerpt from the Commissioner's Report for 1900 describes a typical year:

> Steamer *Fish Hawk:* During July and August this vessel was employed in making collections of marine fauna off the southern coast of New England in connection with the biological work of the station at Woods Hole, Mass., and in September she was sent to Beaufort, N.C., to assist in the topographic and hydrographic surveys incident to an inquiry into the cause of the failure of the various attempts at oyster culture which had been made in the State. At first the work was carried out in the vicinity of Beaufort and Morehead City, but in December the *Fish Hawk* proceeded to Pamlico Sound, where Swanquarter and other productive oyster-grounds were examined. On March 25 the vessel was detached from this duty in order to prepare for taking up the customary shad work in the Delaware River. Some time was spent in making necessary repairs at Baltimore and on April 25 she reached her usual anchorage off Gloucester City, N.J., where shad hatching was successfully carried on until the middle of June, when she was ordered to proceed to Woods Hole.

The value of marine fish culture was questioned by a growing number of scientists by 1910. Propagation success of many freshwater fishes could be measured by the increased productivity of lakes and ponds but marine fishery production naturally fluctuated so broadly that no measure could be relied on. Skepticism originated in Europe but soon Americans voiced similar doubts that the artificial fertilization of eggs and the release of fry contributed significantly to marine fish populations. In 1912, when the *Fish Hawk* underwent a major overhaul, the hatchery cones, cylinders and other hatchery equipment were removed. From 1912 until she was condemned and sold in June 1, 1926, she conducted biological and fishery surveys in Chesapeake Bay, off the Carolinas, in Long Island Sound and in the Gulf of Maine. For a short time in 1918, during World War I, she was on military duty with the Navy's auxiliary fleet.

SUMMARY

The *Fish Hawk* had a long and commendable service with the Fish Commission and the Bureau of Fisheries. During this entire period she was manned by officers and men of the U.S. Navy. She started her career with the oceanic explorations for tilefish along the edge of the Continental Shelf. She approached the mid-point of her service with a survey of the fishery resources of Puerto Rico and during her final years conducted surveys along the Atlantic coast from Maine to Florida. For nearly a half a century she symbolized Federal fisheries research to fishermen and other coastal residents along the Atlantic seaboard.

MFR Paper 1016, from Marine Fisheries Review, *Vol. 35, No. 11, November 1973. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, D.C. 20235.*

MFR PAPER 1017

NMFS scientists find a more efficient and less costly way to transport live crabs to market.

The Overland Shipment of Live Dungeness Crabs by Self-Contained Van

H. J. BARNETT, R. W. NELSON, P. J. HUNTER, A. E. EINMO, and D. N. PLANT

ABSTRACT

The concept of delivering live Dungeness crabs to out-of-the-way markets by truck has been considered from time to time. Because it is difficult to keep the crabs alive beyond 1 or 2 days out of their natural environment, the idea has never proven to be workable. Described here are the results of laboratory experiments to develop such a method. The most successful laboratory method—designed around a system of vertically stacked trays fed by recirculated, chilled seawater—was sealed up and field tested. In two over-the-road tests, one lasting 3 days and the other 4 days, crab losses averaged less than 10 percent.

Live seafood marketing in the United States has been limited mainly to the northern lobster. In other countries retailing live fish and shrimp has been common practice. In Denmark for instance the consumer may choose a live plaice or other fish from a holding tank in a retail fish market. In Japan live shrimp are in great demand. Recently, the possibility for extending live retail marketing in the United States to include Dungeness crab has been investigated for several firms.

A retail market for live Dungeness crab began to develop in 1968 when air shipping techniques were successfully applied. The research leading to this development was reported by Barnett et al. in 1969.

Following the air shipping success the potential for live crab sales in areas not served by airlines became of interest. Some of the small California communities were especially good possibilities since fish markets in these areas had saltwater holding tanks that were being used for holding lobsters. One company tried shipping live crabs by truck to take advantage of such factors as: (1) accessibility to remote areas for processing live crabs and for delivery to the markets; (2) reduced cost; (3) ability to handle a large quantity in a single shipment; (4) and the convenience of delivery to numerous locations along a single route. Using an obsolete refrigerated meat transporting trailer, the company attempted several shipments of live crabs using a technique in which refrigerated seawater was sprayed onto the crabs through common garden sprinklers located throughout the inside of the trailer. The shipments originated in northern California and terminated in Los Angeles. However, after several disastrous attempts at shipping the crabs live, the procedure was abandoned as unworkable. It was at this point that the company heard of the work that the National Marine Fisheries Service had done in shipping live Dungeness crab by air and asked for assistance.

From previous experience in shipping live Dungeness crabs by air it was known that they can be held out of water for about 2 days under ideal conditions. The conditions include: the maintenance of low-storage temperatures, relative humidity of over 90 percent, and the elimination of unnecessary handling. Of these conditions, low temperature and high humidity are of primary importance. Low temperatures are known to make crabs torpid (Roach, 1956) and have been used successfully to produce the same physical effect in other marine species (Rodman, 1963; McLeese, 1958, 1965). The net result of this inactivity is to reduce the animals' apparent need for oxygen (Tomura et al., 1967; Waterman, 1960) because of reduced metabolism. The retention of moisture is necessary to prevent dehydration of the crabs' gills. Dehydration prevents the crab from breathing normally and ultimately will cause death. In conducting the study reported here, particular attention was paid to the prevention of dehydration.

LABORATORY STUDIES

Two methods of live holding were studied in small scale experiments at the laboratory using the trailer as a

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test unit. The purpose of these experiments were: (1) to test fog as a method of maintaining a high level of moisture on the gills and (2) to test partial immersion as a method of maintaining the gills in a moist condition.

Trailer Test Unit

To facilitate our research, a 28-foot trailer belonging to the crab-shipping company was brought to Seattle where the laboratory experiments were made. Because it had already been used to transport live crabs, the interior of the trailer had been covered with fiber glass. Three floor drains were connected by 2-inch polyvinylchloride (PVC) pipes to a 400-gallon capacity reservoir located under the trailer. A centrifugal pump, powered by a 5-hp gas engine (also beneath the trailer), pulled water from the reservoir via three Cuno[1] filters and recirculated it back into the trailer. Refrigeration was supplied by a Thermo-King, front-mounted, butane-powered unit.

Prior to initiating the experiments, the interior of the trailer was modified with a fogging system. The system consisted of an electrically powered, high-pressure pump capable of delivering 6 gpm at 200 psi and two Spraying Systems Company type 7-N fog-jet nozzles. The nozzles were connected about 12 feet apart to a 1½-inch diameter PVC pipe attached to the ceiling of the trailer. A high-pressure hose joined the pipe to the pump beneath the trailer. In these experiments, the floor of the trailer was used as the reservoir. A garden hose from the floor drains connected to the suction end of the pump completed the system.

Fog Experiments

In each of three replicate experiments, 24 live Dungeness crabs were divided evenly among three plastic-webbed baskets (Figure 1). The baskets were stacked three high in the trailer to determine if the spray mist would reach all of the crabs and keep them moist. A second group of 24 crabs divided among three baskets was placed, without stacking, adjacent to the stacked groups. Each experiment lasted 4 days, during which time the temperature of the environment was maintained at 43° F. Because of the mechanical condition of the refrigeration unit, 43° F was about the lowest temperature that could be achieved with any dependability. The crabs were examined daily during the experiments.

Results and Discussion

Even though the atmosphere was saturated by the mist, the crabs in these tests began to succumb by the end of the second day. Maximum mortalities occurred by the beginning of the last day of the experiment. Total losses, based on the number of crabs lost in each test, averaged about 30 percent (Table 1). Mortalities appeared to be evenly distributed among the baskets. Mortalities in the unstacked groups were not significantly different from those sustained in the stacked group.

During each experiment, the pH of the chilled seawater was measured periodically with a pH meter. No significant changes from the normal pH of the brine (7.5 to 8.5) were noted. This indicated, for the conditions described here, that ammonia was not being formed. Crabs surviving these experiments were frequently in a weakened condition. When relocated in the laboratory's live-holding facilities, these crabs usually succumbed quickly.

Although the fog spray technique increased the holding time of the crabs over that of the initial spray method used by the crab shippers, losses were unacceptably high.

Partial Immersion Experiments

Because the fog method resulted in high mortalities, a different approach was tried in which live crabs were held in trays continually flushed with recirculating refrigerated seawater.

Two trays (4-ft x 3-ft x 4-in deep) were made from marine plywood and painted with a nontoxic coating. Openings (18- x ⅜-in) were cut into the short ends and 1 inch above the floor of the trays. The openings were used to regulate the water level in the trays. The 1-inch depth was selected on the basis of previous tests made at the laboratory in which crabs were exposed to different water depths to determine the smallest amount of water in which they could survive without difficulty. It was determined that average-size (1.5 to 2.5 lb) crabs did well in water deeper than half an inch. A frame with supporting glides was made to hold the trays in a vertical or stack configuration. Water was supplied to the top tray by an epoxy-clad submersible pump delivering water at a rate of about 350 gph. The water spilled through the openings in the top tray, to the bottom tray and then onto the floor of the trailer. Vertical stacking of the trays prevented the crabs in the bottom tray from escaping and a screen held the crabs in the top tray. The temperature of the water was maintained at 43° F during the test. The experiment was repeated three times.

Results and Discussion

Between 30 and 50 live crabs were used in each test and to the degree possible crabs were evenly divided among the trays. All crabs selected for the experiments were in apparent good condition.

Despite their condition, however, small but unexplained losses occurred at the 2-day interval in each experiment (Table 2). Additional mortalities occurred near the completion

[1] Mention of trade names does not imply NMFS endorsement; they are used only to simplify descriptions.

Figure 1. (above)—Live crabs in webbed basket prior to holding in fog-spray experiment. Fog-jet nozzles are shown top-center of photograph mounted between two rows of garden sprinklers.

Figure 2. (below)—Arrangement of rails and vertical stanchions to support the holding trays.

Figure 3.—Live crabs arranged in holding trays. Bales for nesting trays are shown hooked in place.

of the studies. Average total losses after 6 days were about 17.0 percent. Surviving crabs were almost always strong and when returned to the laboratory's live-holding facility, they resumed normal activities without difficulty.

Summary of Laboratory Experiments

The laboratory experiments indicated that a seawater fog technique was not a satisfactory method for maintaining Dungeness crabs in live conditions beyond 2 days. Even though the fog constantly bathed the exterior of the crabs, apparently the gills were not kept sufficiently moist under this condition. On the other hand, partial immersion in seawater resulted in a lower rate of mortalities and successful live holding for 6 days. Based on these results we decided to expand the experiments using the partial immersion technique in over-the-road tests using the trailer.

FIELD EXPERIMENTS

The purpose of the field experiments was to determine if the results obtained in the laboratory scale tests could be repeated under conditions more like those found in actual shipments. In addition, large-scale tests would be useful in assessing factors such as: loading and unloading the trailer, scheduling, and other problems that might be encountered (aside from those involved in maintaining crabs in live conditions). The tests were arranged by the owners of the trailer, using suppliers and outlets that the company had made prior to our involvement in the experiments. All costs and obligations associated with the field tests were borne by the company. Our responsibility was limited to recommending the procedures to be used and in making an objective evaluation of the results.

Trailer Modification

All pipes, hose, and nozzles were stripped from the van and replaced by a system of aluminum channel tracks. The tracks ran the length of the trailer's walls and were attached to vertical stanchions located at intervals along the length of the trailer and about 21 inches in from the walls (Figure 2). The spacing allowed for suspending 18- x 24- x 4-in (deep) polyethylene trays made with 1½-

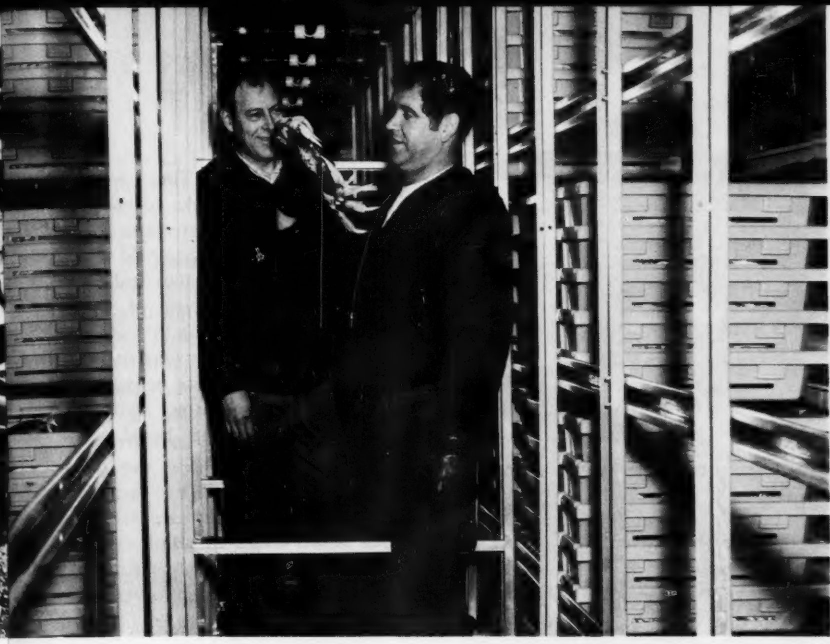


Figure 4.—View of stacked trays loaded with crabs.

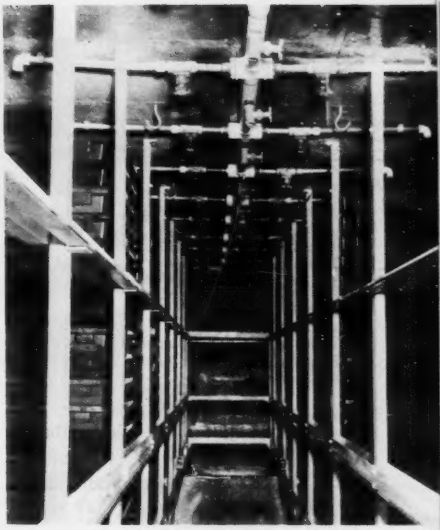
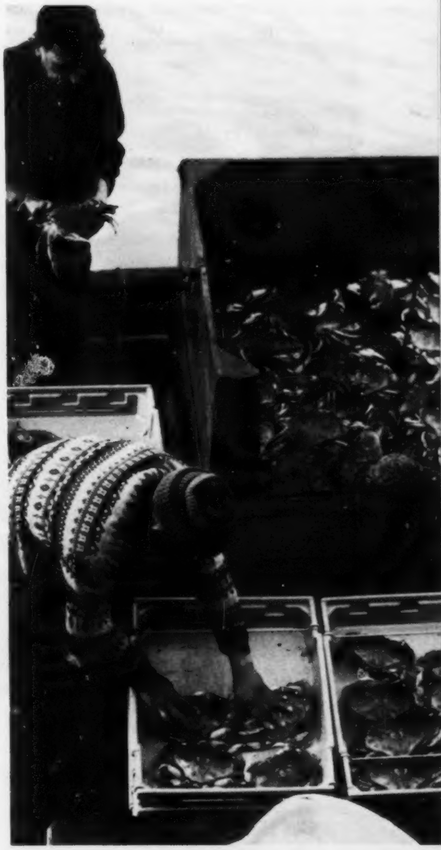


Figure 5. (above)—Arrangement of PVC distributor pipes (top, center) feeding chilled seawater to trays loaded with crabs.

Figure 6. (below)—Live crabs being loaded into trays without the aid of restraints.



inch rims between the tracks. When completed, each side of the trailer had a system of three sets of tracks vertically spaced to accommodate trays nested one on top of the other. Special bales prevented the trays from nesting in each tray deeper than 1 inch (Figure 3). The overhanging rim of the bottom trays in each stack rested on the tracks and supported the other four trays in the stack. Each side of the trailer accommodated 10 stacks of 15 trays or a total of 300 trays (Figure 4).

Water was carried to the trays through 1-inch PVC distributor pipes teed from a 1½-inch PVC pipe attached to the ceiling of the trailer. The flow of water through the distributor lines to the trays was regulated by plastic hand (gate) valves. Water from the distributor lines was pumped into the top trays of each stack, overflowed through ⅜- by 12-inch openings cut into the short ends 1 inch above the floor of the trays and down into each succeeding tray (Figure 5). Water was drained from the trays by means of five ¼-inch holes located in the floor of each tray. The holes were placed in each corner about 2 inches in from the sides and one in the center of the tray floor. When in operation, water flowed into the trays at 6 gpm. Each tray held about 2 gallons of water. Water dropped from the bottom trays to the floor where it was pulled down the floor drains into the reservoir through the filters and recirculated by the gas-driven centrifugal pump. Baffles on the floor of the trailer reduced the problem of surging water when the trailer was in motion. The temperature of the trailer was maintained at 43°F. All water used in the trucking experiments was pumped from local saltwater bays. Two experimental shipments were made.

First Road Experiment

Procedure

The first shipment was made from a crab-buying station located on the Washington coast. Thirty-six hundred pounds of sea-run[2] crabs were hauled via Seattle, Washington, to Portland, Oregon. The trip was purposely kept short (about 300 miles) to enable us to observe the effects of road vibra-

[2] Sea-run crabs have not been culled for damaged, broken shell and missing legs but are taken "as is" when unloaded from the boat.

Table 1.—Daily mortalities (%) occurring in Dungeness crabs held in stacked and unstacked basket containers exposed to a 43°F. fog-spray[1]

Days held	Crab mortalities (%/day)[2] in stacked baskets (Test) 1	2	3	(Avg.)	Crab mortalities (%/day) in unstacked baskets (Test) 1	2	3	(Avg.)
1	0	0	0	0	0	0	0	0
2	4.2	0	4.2	2.8	0	6.5	0	2.2
3	8.3	8.3	16.6	11.0	0	12.5	6.5	9.7
4	16.6	12.5	16.6	15.2	18.8	12.5	25.5	18.9

[1] Results are based on data collected from three separate experiments.
[2] Figures are based on the number of crabs lost in each experiment compared to the number of live crabs used initially.

tion on the crabs and evaluate the effectiveness of the trailer's life-support system. The crabs were individually placed by hand in the trays which had been removed from the trailer for the loading operation (Figure 6). Because the crabs were not restrained in the trays, considerable time was used to complete the task of loading. As the trays were filled (eight crabs per tray) they were weighed and loaded into the trailer. When a vertical stack was completed, a flow of seawater, pumped into the trailer prior to loading, was started to prevent the gills of the crabs from drying. The time required for 9 men to complete the loading operation was about 7 hours.

Results and Discussion

Part of the trip to Portland was made over secondary roads which were rough in spots. During this segment of the trip, several members of the crew rode with the crabs in the trailer to observe their reaction to the ride. As far as could be determined, the crabs were not unduly excited by the occasional jarring and bumping. Although some water spilled from the trays when the truck moved up or down steep grades, the crabs were never without water very long during the trip. The crabs were restricted from moving freely because of the nested tray configuration and their close proximity to each other. The darkened interior of the trailer and cool temperatures also contributed to the crabs' relative inactivity. Examination at the time of delivery showed that physical damage was minimal.

The shipment was held overnight in Seattle then trucked to Portland, Oregon, where 2,500 pounds were delivered to a retail market. Prior to unloading, the water was drained from the trays. Draining took about 20 minutes and was accomplished by closing appropriate valves and allowing the water to drain from the trays through the holes drilled into the bottoms. The crabs were then unloaded, carefully examined and weighed. A 10-percent allowance was made for entrapped water that did not drain off. Accordingly, this was deducted from the total unloaded weight. Four percent of the delivered crabs were dead. The survivors were lively and in excellent condition. They were placed in live display tanks for sale.

The remaining crabs were returned to Seattle where they were held an additional 48 hours in the trailer. Seven and one-half percent of the remaining crabs died during this time. The surviving crabs, which were lively and in good condition, were delivered to a local crab processor. Overall losses in this experiment, based on total weight, were 4 percent.

Table 2.—Daily mortalities (percent) occurring in Dungeness crabs held in vertically-stacked trays partially flooded with 43° F. recirulated sea water.[1]

Days held	Crab mortalities (%/day)[2] (Test) 1	2	3	(Avg.)
1	0	0	0	0
2	4.0	3.0	4.0	3.7
3	0	0	0	0
4	0	0	0	0
5	0	6.1	7.9	4.7
6	10.0	6.1	13.1	9.7

[1] Results are based on data collected from 3 separate experiments.
[2] Figures are based on the number of crabs lost per day in each experiment compared to the number of live crabs used initially.

Second Road Experiment

Procedure

Because the life-support system performed well during the first experiment, a second trip of longer duration and larger numbers was initiated. As in the first experiment, the crabs were obtained from the coast of Washington. Forty-two hundred pounds were taken directly from the live well of a crab boat, weighed (after draining) and placed in the plastic trays. The problem of placing the crabs in the trays was eliminated by using aluminum separators (Figure 7) made especially for this experiment. The separators, resembling egg carton separators, divided the trays into eight separate compartments, one crab per compartment. In this way, the crabs were kept relatively quiet. When full, the separators were carefully removed and an empty tray placed on top, loaded, and so on. When enough trays were filled with crabs, they were weighed and loaded into the trailer. Using this technique seven people handled and loaded the crabs in about half the time required in the first experimental road test. As soon as the crabs were loaded and the life-support systems operating, the crabs were trucked to southern California. The trip covered a distance of about 1,500 miles and lasted 4 days.

Results and Discussion

Deliveries of crabs weighing from 500 pounds to 1,000 pounds were

made to six live seafood markets during the trip. Except for weak crabs, which were immediately cooked, all active crabs were placed in live display or storage tanks when unloaded (Figure 8). Dead crabs could not be sold and were disposed of. Mortalities for this experiment, based on the total weight shipped, was 5 percent. Dealers were very impressed by the liveliness of the crabs and absence of broken shells and lost legs. Damage was not considered to be significant. Delivery of the crabs direct to the market also pleased the dealers since air shipment of live crabs requires that they pick them up at an airport or have them delivered by an air-freight forwarder. Either operation is expensive and time-consuming.

Special handling procedures used to remove air trapped beneath the shell of the crab were not necessary in this or the first trucking experiment. Because the crabs were partly submerged during the trips, the water displaced the air sometimes trapped under the shell of dry packed crab.

Air causes the crabs to float when returned to live holding facilities. The problem is usually eliminated by holding the crab partly submerged in water until the air is displaced and the crab can sink. The procedure requires considerable time, especially when large numbers of crabs are involved.

Although pH measurements were not made during this and the first experiment, bacteria did not appear to be a problem as evidenced by the absence of off odors, including that of ammonia. Dissolved oxygen, also not measured in these experiments, did not appear to create a problem with respect to the crabs in that they were always active and alert when examined.

Time restrictions and limited experiments precluded considering the economics of the procedure. However, the relatively few crab losses, the enthusiasm of the retail buyers, and the success of the experiments indicated that this method of delivering live Dungeness crabs to market has considerable potential.

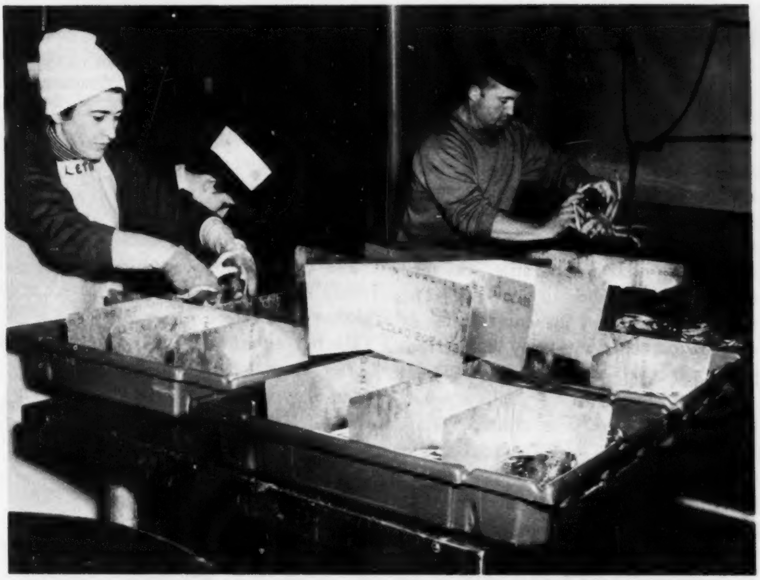


Figure 7.—Aluminum separators used to restrain crabs during tray-loading procedure.

Figure 8.—Customer selecting a live crab from display tank.

SUMMARY AND CONCLUSIONS

Two experimental methods for keeping Dungeness crabs alive during long-distance hauling by truck were designed and evaluated in the laboratory. In the first experiment, a refrigerated seawater fog-spray, produced by a high-pressure pump and special fog-nozzle apparatus, was tested on crabs held in baskets. The technique resulted in mortalities of over 30 percent in a 4-day test period.

The second method was designed around a system of vertically-stacked trays supplied with a chilled, recirculated seawater that cascaded from tray to tray. Openings on the ends of the trays regulated the water level at a depth of 1 inch so that the crabs were continuously in enough water to maintain life without having to be completely submerged. Crab losses in replicate tests lasting 6 days were less than 17 percent.

Based on the results, the method was scaled-up for field testing in a truck-trailer combination. Crab losses in each of two over-the-road tests, one lasting 3 days and the other 4 days, averaged about 10 percent.

In conclusion, the method for handling and shipping live Dungeness crabs, as described above, appears to have considerable potential. Furthermore, the technique may have application to lobsters, fresh-water crayfish or other aquatic animals. However, if other animals are considered, experimental work is necessary to establish the efficacy of the method as it applies to each species.

ACKNOWLEDGMENTS

Our thanks to Tony Borges, owner of Ready-Mix Trucking, Torrance, California, and his associates; and to Lloyd Lorton, owner of Lorton Enterprises, Bay Center, Washington, for their assistance and cooperation in making these experiments.

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MFR Paper 1017, from Marine Fisheries Review, *Vol. 35, No. 11, November 1973. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, D.C. 20235.*

In a classic conflict, herring tests the ability of the political process to manage a renewable natural resource.

San Francisco Bay Area's Herring Resource — A Colorful Past and a Controversial Future

MAXWELL B. ELDRIDGE
and W. MICHAEL KAILL

INTRODUCTION

Discuss Pacific herring with the people of Tomales Bay or the northern counties of San Francisco Bay (Figure 1) and you will very likely encounter the two edges of a sharp sword. The sword aims at a fish resource which has become a classic example of the conflict over natural resources. The issue is still unsettled.[1] The Pacific herring fishery remained quiescent over the last two decades, and there has been little interest shown for management of the population. The fishery landed 53,235 pounds five years ago and only 21,700 pounds during the 1971-72 season. Then a new market opened this last winter and the catch rose to over 2 million pounds. The rush to the harvest brought attention from local conservationists and legislators. Their efforts resulted in legislation which effectively controlled the herring fishery.

This paper includes some historic background of the San Francisco Bay area Pacific herring (*Clupea harengus pallasi*) which predates the gold rush days. It discusses the known biology of the herring and the research being conducted to find out more about the species. Lastly, it presents the latest in a series of events which may ultimately determine the fate of this population of fish.

HISTORY OF THE RESOURCE

Studies of the bottom sediment of Tomales Bay showed that Pacific herring were residents of the San Francisco Bay area waters long before it was colonized by man. San Francisco was just a sleepy town with only 375 inhabitants as recently as 1847. In those early times, the local fish resources, including herring, remained relatively untouched. Then gold was discovered, and within two years the population rose to 25,000 people. With this growth came a demand for food. The first interest in herring was for fresh fish which were sold for "two bits a bucketful." The only export interest at that time was in rough salted fish which were sent to the Orient.

The fishery grew slowly; small amounts were used for smoking, curing, and canning. Attempts to export local herring to Europe to compete with Atlantic herring met with limited success. With continued efforts and the advent of World War I there eventually arose a large demand for Pacific herring for canning and reduction to oil and meal. The catch rose to 8 million pounds by 1918 (Figure

[1] Data and events current as of 23 August 1973.

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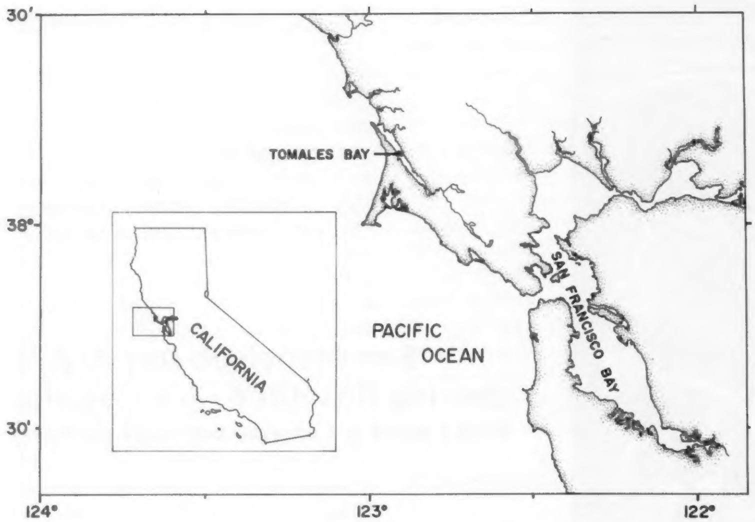


Figure 1.—Map of the San Francisco Bay area.

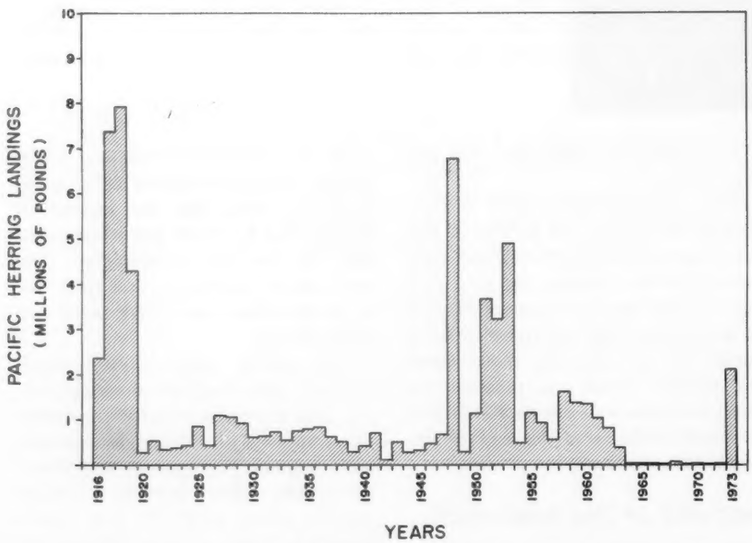


Figure 2.—Pacific herring landings of the San Francisco Bay area (Tomales and San Francisco Bays).

2). At that time the Tomales Bay herring were considered the best in California—they were fatter and longer. The fish were brought from Tomales Bay on a narrow gauge railroad to the city of Sausalito, in San Francisco Bay, then shipped upriver to canners in the Sacramento River delta. The Federal Bureau of Fisheries advised the fishery in its curing and processing. The herring were Scotch cured and canned. It was the first time the fishery was tested for its capacity and it was believed that the herring take could be doubled and still not damage the resource.

In 1919 the California State Reduction Act was passed which prohibited reduction without written permission from the California Department of Fish and Game. This legislation effectively reduced landings of herring to an all time low. The fishery returned to landing small quantities for fresh consumption (bait, smoked, and salted). This trend continued from 1920 to 1946.

With the decline of the California sardine fishery, herring became a hopeful substitute for the sardine. Canning operations began again with herring trucked in from Tomales Bay. In the early and mid-fifties boats with lampara nets sailed from Monterey to Tomales Bay, where catches brought large increases in the recorded landings (Figure 2). The Bay Area catch rose to 3.6 million pounds. However, herring proved unsuitable as a sardine substitute, and only a small pet food market continued to provide a limited demand. But even this market did not hold and the catch declined to a little over 30,000 pounds by 1964. The main use until recently has been bait.

A new fishery began in 1965-66 related to the herring eggs themselves. The products are exported to Japan as gourmet food. The roe is utilized in two forms. "Kazunoko" is entirely roe, usually the whole ovary. "Kazunoko-kombu" is the herring eggs-on-kelp product. Both are expensive specialty foods, usually consumed on holidays and special occasions.

A permit was issued for 5 tons of herring eggs-on-kelp in Tomales Bay and 5 tons in San Francisco Bay. The permit for Tomales Bay was later cancelled for two seasons to allow the Department of Fish and Game to study the resource. This permit was then reissued this last 1972-73 season. The eggs-on-kelp fishery is still in operation and has been moderately successful. On the basis of Fish and Game Department records, the San Francisco Bay fishery has never collected more than one-half of the quota, and the Tomales Bay fishery approached its quota only once.

The demand for roe was responsible

for a dramatic change in the adult herring fishery this past season. Over 2.1 million pounds of whole adult fish were landed. Due to continued restriction by the 1919 Reduction Act the whole fish could not be reduced in the United States and there was no market for other herring products. Therefore, the fish were frozen in the United States and shipped to Korea for processing. There the roe was removed and sent to Japan while the fish were dried and sold for human consumption in Korea.

The recent tremendous increase in the fishing effort, with its high catches, was one of the reasons for the controversy over the resource.

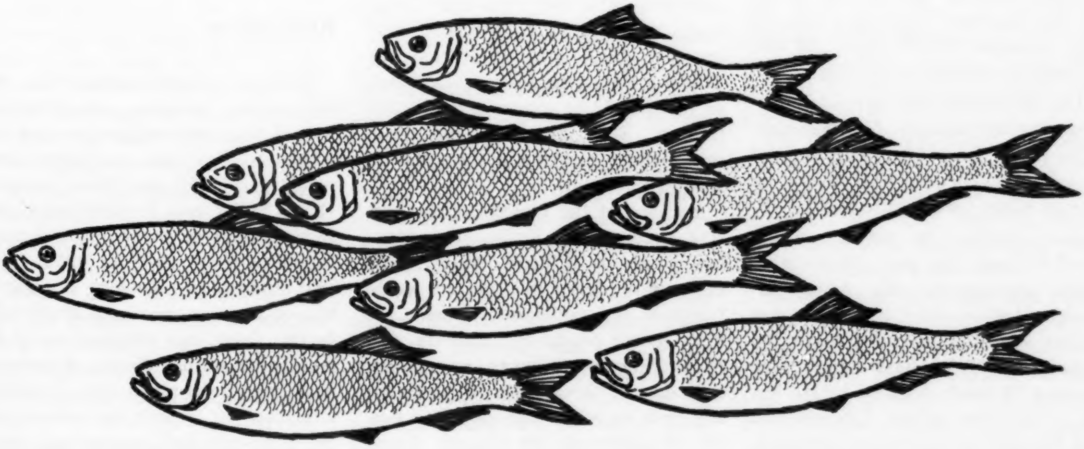
BIOLOGY OF THE PACIFIC HERRING

Probably, the biggest factor keeping the herring controversy alive and vigorous is the high visibility of the actual fishing operations. The harvesting of both the herring eggs-on-kelp and adult fish takes place in waters adjacent to populated areas. The biological nature of herring is responsible for this.

Unlike the Atlantic herring, which spawns in deeper water, the Pacific herring spawns in the intertidal waters, and in the San Francisco Bay area, they most often spawn along heavily developed shorelines. Although spawning occurs from November to June, peaks of spawning activity occur earlier in the southern populations.

We have netted larvae of the herring in San Francisco Bay as early as late October and early November, long before evidences of the adults are found. Evidently, there is some very limited early spawning. Maturing adults usually enter San Francisco and Tomales Bays up to 2 months before spawning, where they remain in loosely aggregated schools in deep holes.

Observations of the Tomales Bay herring showed that a few days prior to spawning the fish's behavior changes. The schools are more predictably found in the deeper holes of the Bay; the fish exhibit less response to adverse stimuli such as outboard motors, etc., and the densities of the individual schools change. When the right set of conditions prevail, the fish move into intertidal shallows and spawn on any suitable substrate. The fish appear to have preferences for their substrate—choosing first algae and grass, then prominent rocks, and lastly flat surfaces. But once dense spawnings begin, such as occurred in 1971-72, every available surface (including ropes, sandy beaches, and boat hulls) is covered with eggs. The eggs are extremely sticky for a short period after the eggs leave the female. Often it is difficult to remove freshly spawned eggs from one's hands or vegetation without destroying the eggs. Although most spawning seems to occur at night, we have observed spawning taking



place day and night during all tidal stages.

The act of spawning involves repeated passes close to the substrate by females, while males release their milt in the general area. The water often appears "milky" over the entire spawning area.

The eggs are usually deposited 1 or 2 eggs thick but can be in layers up to 2 inches. When the latter occurs we have found very poor survival among all but the outlying eggs.

The most noticeable eggs are those in the intertidal zones—the ones exposed at low tide stages. Actually, the spawning continues subtidally to approximately 25 feet in Tomales Bay and at least that and probably deeper in San Francisco Bay. The fish are usually 3 to 5 years old when they spawn. Work by the junior author showed that over 13 percent of the 1971-72 catch from Tomales Bay was 5 to 8 years old. This is a change from a 1955 study in which less than 3 percent were 5 years old and these were the oldest in the catch. The older age composition of this last year's catch suggests that the population has been under low fishing pressure.

The number of eggs each female produces depends on the size of the fish. For example, a female 7.6 inches long produced 18,600 eggs and one 8.7 inches long had 29,500 eggs.

The incubation time depends mostly on the temperature. Our measurements of the last season's eggs showed the larvae hatched in 10.5 days at an average water temperature of 50.7° F.

Once hatched the larvae are believed to leave the bays. Preliminary results corroborate this belief, although Alaskan and Canadian studies suggest that the juveniles leave the bays in the fall. We have caught large numbers of newly hatched larvae but few of the later stages. Undoubtedly high mortality is a factor on both eggs and larvae as many predators gather at the spawning grounds—gulls and other waterfowl, sturgeon, striped bass, sharks, etc. Depth of water is critical for egg survival. Mortality may range from <5 percent in deep water to 99 percent or more for intertidal spawnings, where the eggs are available to a larger variety of predators.

Where the fish go after they leave the bays is unknown. There is a summer fishery for the adults in Monterey Bay to the south of San Francisco Bay but their origin is also unknown. This past year the state Department of Fish and Game showed that herring could be tagged and survive. If results from Canadian tagging studies are valid for these fish, the local tagging program should show that they move offshore and return to spawn again, using a homing instinct.

Pacific herring make up a series of different intergrading populations from Japan and Korea, north to the Bering Sea and southward along the Pacific coast to Baja California. The population found in the San Francisco Bay area is small compared to those found along the British Columbia coast, where the spawnings are measured in miles of beaches covered with eggs. The San Francisco population is constituted of younger and smaller fish and by slower growth and sexual maturation at younger ages and earlier spawning. The San Francisco population size has been estimated only once, in 1955, at 12,000 tons. The Tomales Bay population was estimated in 1971-72 at approximately 4,000 tons by State biologists and again this last season by the junior author at around 4,000 tons.

Because of the biology of the herring, prediction of forthcoming population size is difficult. Many more eggs are produced than are needed to maintain the population. Losses are high due to predation, exposure, and smothering. Even after the eggs hatch, mortality of larvae, due to predation and drift away from proper food supply, is commonly 99 percent. Those that make it through such a risky early life are still reduced by about half each year. That is, in the process of growing one year older (e.g. three to four years of age) 40 to 60 percent of the population is lost. Because of the interaction of high reproductive potential and high losses due to natural mortality, strange things can happen. Unsatisfactory conditions can cause high mortality of a spawn, regardless of the tonnage of eggs produced. Thus, a poor spawn may produce a very good crop of young fish; or an abundant spawn may produce a poor result, if conditions are poor. Understandably, prediction of the amount of fish produced based on spawning success is difficult. Herring do not enter the shallow water spawning runs until they are two or three years old. Thus, studies based on spawning populations of herring are forced to exclude many of the fish in the total population.

When a spawning does encounter advantageous conditions, many of the fish of that particular spawning (for instance, 1971-1972) survive, producing what biologists call a successful year-class. By studying the age composition of the spawning adult populations it is possible to follow a successful (i.e. abundant) year-class over a number of years.

RESEARCH

Despite the long history of the fishery and the resource, very little biological research was done on the San Francisco Bay area population until recently. In 1955, two State biologists, D. J. Miller and J. Schmidtke, presented results of the commercial catch sampling from 1947 to 1952. They also studied the spawning population that occurred in the winter of 1954-55. In this study, age composition of the population and the density of spawned eggs were determined. The biologists attempted to delimit the school size by echo-sounding equipment when the fish were held up in the deeper portions of San Francisco Bay, but they found the schools too mobile. For the first time, they estimated the

Figure 3.—Examples of a natural rock (left) and artificial spawning substrate used in recent studies of the San Francisco Bay, January 1973.

size of the Tomales and San Francisco populations using the amount of spawned eggs as the measure.

No further work was carried on for another 15 years. Then the herring eggs-on-kelp fishery brought the need for an assessment of the herring egg resource. J. Hardwick, also of the Department of Fish and Game, studied intensively the spawning populations of herring for two consecutive seasons beginning in 1970-71. He surveyed the spawned eggs and vegetation in Tomales Bay using techniques developed by Miller and Schmidtke, and himself. This study was set up to evaluate both the adult fish population and herring eggs-on-seaweed resources. As a result, he recommended that "a harvest of 10 percent (16 tons) of the eggs that hatch would not significantly reduce the number of eggs that hatch," and "should tonnage of whole fish exceed 500 tons it may be necessary to reduce the quota on eggs."

Both the senior and junior authors have conducted independent studies this last 1972-73 spawning season. The senior author's work consisted of two transects or lines of numbered cement discs (Figure 3) which were used for artificial spawning substrates. The commercial catch was sampled to look at the ages, sex ratio, fecundity, and size of the spawners. Preliminary results show a very light spawning in San Francisco Bay this year. The fish hatched in an average 10 days at approximately 50° F water temperature. The fish spawned along the entire transect but lower depths showed lesser egg densities, probably because of poor substrate and high sediment at the deeper locations.

The junior author simultaneously studied the herring in Tomales Bay. The commercial catch was also sampled and an attempt was made to estimate the size of the spawning population by sonar equipment and by surveying the amount of eggs actually spawned in the Bay. Besides the results we have already mentioned other interesting facts were noted.

From observing schools of herring as they became ready to spawn, characteristic behavior was seen which might be of value in predicting the time of spawning. By virtue of the school's compactness and stable positioning, relatively good success was achieved in estimating the volume of herring schools. This could provide a much simpler and less time-consuming method of estimating the population than surveying the actual spawned eggs with the aid of SCUBA gear or by using specialized bottom samplers.

Some answers to questions concerning migration of juvenile and adult fish between spawnings could result from a tag and recovery program begun last year by the State. San Francisco Bay fish were tagged and released after spawning. This next fishing season should show results if the fish, in fact, do remain in or return to local waters.

FISHERY

The methods employed by the commercial fishery over the years are fairly traditional, reflecting the efficacy of those processes. The original fishery used beach seines and gill nets (Figure 4). In 1917, the Bureau of Fisheries advised the fishermen to develop purse seines, lampara nets and larger boats.

The decline of the fishery evidently discouraged such development and the fishing gear and methods did not change until 1952 when lampara boats equipped with sonar equipment fished the populations in Tomales Bay. Up to this last year the same methods have been used, with the introduction of lighters being the only advancement in technology (Figure 5).

The herring eggs-on-kelp are harvested by hand by divers. Since the weather during the spawning season is usually the most inclement time of the year, it is understandable why the quotas have not been filled.

Adult herring have been sold fresh, salted and cured, and attempts at canning have met with varied success. Competition from Atlantic herring and larger northern Pacific herring from Canada and Alaska have made the product not economically profitable. The recent export market includes the sale of dried whole fish to Korea for domestic consumption and the sale of roe to Japan.

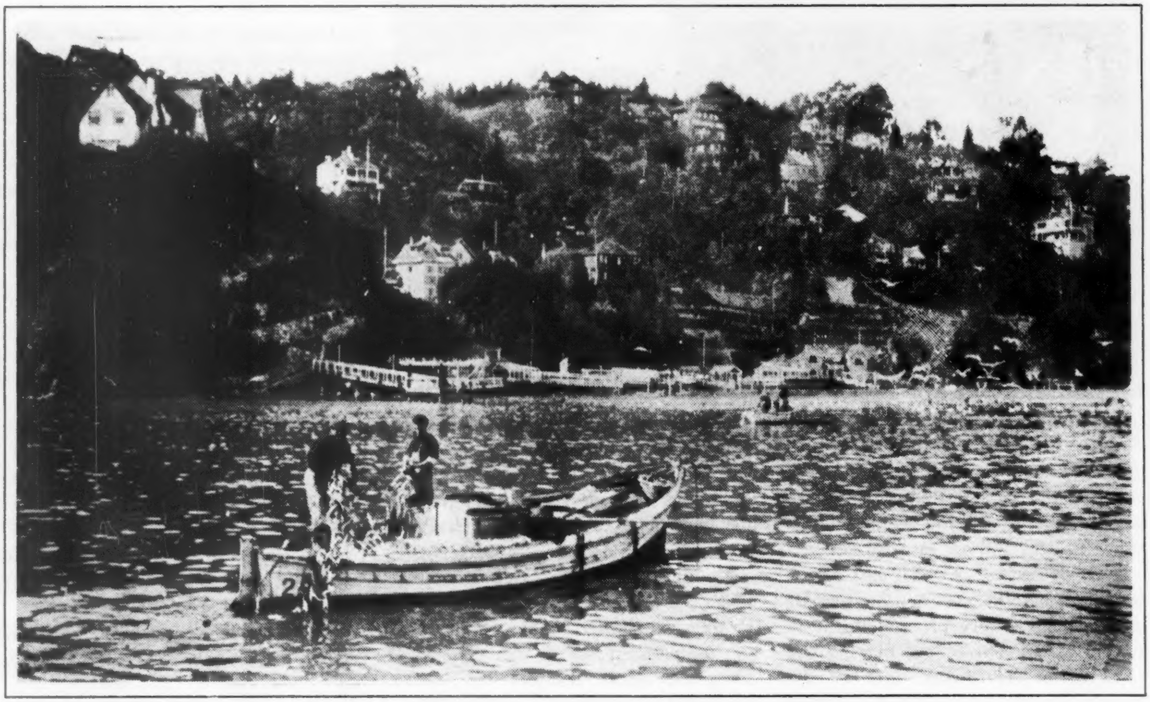


Figure 4.—Herring gill netters at Belvedere Cove, San Francisco Bay, January 1918.

THE DEVELOPING CONTROVERSY

Over 20 years ago the local citizenry openly criticized the fishermen for their use of large boats and new gear which resulted in the large landings of Tomales Bay herring. Now in 1973, essentially the same gear and boats fished the same resource resulting in much the same reaction from the public. The difference, however, is that the most recent public concern was converted to political action limiting the take of herring.

One common feature of both whole fish and eggs-on-kelp fisheries is the high visibility of the fishing activities. Local citizenry, especially some sportsman's organizations were alarmed with what they saw; alarmed to the extent that they persuaded a State Senator to introduce legislation immediately, which subsequently passed, instituting a revocable, nontransferable permit system for harvesting herring and herring eggs in Tomales and San Francisco Bays. It also directed the Department of Fish and Game to develop a management plan and present it to the Commission with the Department responsible for management in the interim period. The bill was signed January 23, 1973, and was operative for 60 days. The Department established quotas of 750 tons for Tomales Bay and 1,500 tons for San Francisco Bay herring. Subsequently, the season in Tomales Bay was closed.

Senator Peter H. Behr, the man who introduced the previous emergency legislation, entered a bill (S.B. No. 502) which prohibits the taking of herring for commercial purposes, except for bait. Another bill (A.B. No. 2309) introduced by Assemblyman Bob Wood at the request of the California Department of Fish and Game, is designed to allow management of the resource through permit issuance by that Department. Both bills are being reviewed by legislative committees.

Whatever decision is made on these bills will most likely be a compromise which will establish a set quota on the fisheries. Thus, a long and heated controversy may soon be resolved as a compromise is reached by legislators acting on information from state, federal, and private research efforts.

The character of the compromise will reflect the ability of a political process to manage a wildlife resource.

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Figure 5.—Lampara net catch of Pacific herring from Tomales Bay, January 1973.

MFR Paper 1018, from Marine Fisheries Review, *Vol. 35, No. 11, November, 1973. Copies of this paper, in limited numbers, are available from D83, Technical Information Division, Environmental Science Information Center, NOAA, Washington, D.C. 20235.*

U.S. Cooperates To Study Atlantic Fishery

Fisheries research vessels from the Soviet Union, Poland, West Germany, and France were engaged in joint surveys with the United States in international waters off the North American east coast during the past three months.

The first foreign vessel to arrive, the 230-foot *Belogorsk*, docked at Woods Hole, Mass., on August 23. The Soviet scientists worked with scientists of the Commerce Department's National Oceanic and Atmospheric Administration under terms of a U.S.-Soviet agreement for the Mid-Atlantic. NOAA's National Marine Fisheries Service maintains its Northeast Fisheries Center at Woods Hole, and the Center's famous research vessel, the 187-foot *Albatross IV*, also participated in the studies.

Dr. Robert L. Edwards, Director of the Fisheries Center, said the Soviet Union has cooperated with the United States for the past six years under the bilateral agreement on surveys of waters of the western Atlantic. Again this year, some 75,000 square miles of ocean between Nova Scotia and Cape Hatteras will be surveyed. The scientists will study the status of ground fish populations such as haddock, cod, flounder, hake (whiting), and redfish (also known as ocean perch). They will also study changes in abundance and distribution of these commercially valuable stocks.

The joint U.S.-Soviet surveys held each spring and fall yield an index of the relative abundance of available fish and provide estimates of spawning success used to predict the quantities of young fish that should be available in subsequent years. On the whole, the surveys are regarded as among the most thorough, standardized, and comprehensive measures of the production of a particular ecological system. The *Belogorsk* and the *Albatross IV*, were slated to make four port calls at the Woods Hole Center before the mission ends in November.

Three other foreign vessels—the *Weiczno* (Poland), the *Cryos* (France), and the *Anton Dohrn* (West Germany)—were to share in additional cooperative research projects. Each, in addition to the *Belogorsk* and the *Albatross IV*, departed in turn for work on an individual two-week leg of a five-part project authorized by the 16-member nation International Commission for the Northwest Atlantic Fisheries (ICNAF). The projects will concentrate on surveys of larval herring abundance between Cape Cod and Nova Scotia, taking samples of those early life stages of herring which float in surface waters. The Polish, French, and West German vessels were scheduled to arrive in late August, September, and October.

This is the third fall that ICNAF nations have cooperated to gather information on spawning populations of herring in the Northwest Atlantic. The *Cryos* was in Woods Hole in 1971 to participate in the first such survey, and both the *Wieczno* and the *Anton Dohrn* were in Woods Hole to participate in last fall's survey.

Commissioned in December 1972, the *Abatross IV* operates out of Woods Hole, Mass.

Billfish Tagging Awards Presented

The third annual Gardiner Foundation Awards, established by the late Tom Gardiner, a prominent San Francisco sportfisherman, were awarded July 30 to the Mexican sportboat captains who tagged and released the most marlin and sailfish during the period June 1, 1972 to May 31, 1973. James Squire, fishery biologist at the National Marine Fisheries Service Laboratory in La Jolla who maintains the official records for the tagged fish made the presentations at the several fishing resorts located around the tip of Baja California.

The top cash awards of $100 went to Jesus Araiza Ruiz of the Rancho Buena Vista, who tagged 60 marlin and 17 sailfish in the eastern contest area, and Pablo Cesena Aripez of the Hotel Cabo San Lucas, who tagged 21 marlin and 10 sailfish in the southern contest area.

Engraved plaques also went to the first three place winners in both contest areas and to Hotel Cabo San Lucas in the southern area and to the Rancho Buena Vista in the eastern area for their efforts in encouraging the captains to tag and release billfish.

The Gardiner Awards were instituted to encourage the fishing boat skippers to participate in the cooperative Marine

Game Fish Tagging Program off the tip of Baja California where each year many of the world's most enthusiastic sportfishermen come to try their luck at catching billfish. In addition to the National Marine Fisheries Service, an agency in the US. Department of Commerce, National Oceanic and Atmospheric Administration, the program is also sponsored by the Woods Hole Oceanographic Institution, the International Gamefish Association and the Mexican Department of Fisheries.

Astronauts, Sport Fishermen, Scientists Coordinate Ocean Study Operations

A turnout of more than 550 anglers fishing for sport and science aboard 138 boats in the northeastern Gulf of Mexico during a recent big-game tournament made the event one of the two or three biggest in the history of such tournaments. At the finish of the two-day contest, fishermen had boated a total of 33 potential trophy fish consisting of billfish, dolphin, and wahoo.

It was an historic "first" in marine scientific circles as well—combining, as it did, the extensive data-collecting capabilities of sea-surface platforms, sensor-equipped aircraft, and two satellites. The scientific aspects of the investigation were under the joint sponsorship of the Commerce Department's National Oceanic and Atmospheric Administration and the National Aeronautics and Space Administration. Coordinating the volunteer fishing program were six fishing clubs and charterboat associations headquartered in Alabama, Florida, and Louisiana.

The scientific and sporting event began in the early morning hours of Saturday, August 4. The sport-fishing fleet cast off from (and virtually emptied the docks of) three Florida Gulf Coast ports—Destin, Panama City, and Pensacola—to await the Skylab overpass and to take part in the two-day fishing tournament, which ended officially at 3 p.m., August 5.

The big moment came shortly before noon of August 5, as Skylab orbited on its Track 62, when Astronaut Alan Bean said to companion Jack Lousma: "Let's see what we can do to help the fishermen down there." "Check," said Lousma, and the advanced sensors of Skylab's Earth Resources Experiments Package were concentrated on the earthbound force of anglers and oceanographers. The objective was to relate stocks of sport fish to ocean features detectable by sensors carried aboard satellites and specially equipped aircraft.

The bluewater fishermen operated from 20- to 57-foot craft scattered over a 3,600-square-mile triangle, in a site set to match the orbiting pattern of Skylab. Accompanying the fishing fleet were nine oceanographic research vessels. Two NASA aircraft made repeated sweeps over segments of the study area. A U.S. Navy plane also flew over the flotilla at some 2,000 feet above the water and took oceanographic readings at the sea surface.

On completion, the NOAA Principal Investigator for the mission, William H. Stevenson, declared that it had been a "near-perfect" exercise. He said that every detail of the program was "in place and on schedule, 'doing its thing,' including the fish.

"This NOAA-NASA investigation was a most impressive demonstration of many diverse groups working cooperatively toward a common scientific goal," Mr. Stevenson said. "It gives us a data base upon which to test the relationship between game fish and their environment; it also enables us to ascertain which environmental characteristics of the ocean can be observed from remote sensing aircraft and satellite platforms."

Mr. Stevenson, chief of NOAA's National Marine Fisheries Service Engineering Laboratory headquartered at the Mississippi Test Facility (Bay St. Louis) was involved in a series of earlier studies designed to relate satellite-acquired information to that gained in traditional oceanographic investigations, leading to the ambitious sea-surface-to-space experiment.

The Fisheries Service directed and coordinated the work of the anglers, who kept careful records of all fish sighted, hooked, and caught. The NOAA research vessel *Oregon II* stood at anchor on the fishing grounds, operating as mothership and floating laboratory for the fleet; NOAA's R/V *George M. Bowers* and R/V *Kingfish II* collected oceanographic data in company with the five chartered research boats. The environmental satellite NOAA-2 scanned the region twice daily from an altitude of 900 miles.

NASA directed the activities of the Skylab astronauts. NASA's Johnson Space Center, through its Earth Resources Laboratory, operated the two aircraft—a C-130 and Beechcraft—which employed an array of cameras and other sensors much like those carried by Skylab to monitor the site from the relatively close ranges of 10,000 and 20,000 feet overhead. The ERL also directed the activities of its surface research vessel, *The ERL*, which functioned as the "hub boat" and maintained radio contact with all members of the fishing and research fleet. The Marshall Space Flight Center provided extensive laboratory and field-site support. The NASA units involved also operate from the Mississippi Test Facility, Bay St. Louis.

Fishing tournament officials restricted competition for trophies to seven offshore species: blue marlin, white marlin, sailfish, wahoo, dolphin, bluefin tuna, and yellowfin tuna. Minimum weights were set for wahoo, dolphin, and the tunas. To be eligible for prizes, catches had to be taken in the daytime between 9 and 3 o'clock, and weighed and measured at one of the three official port stations at Destin, Panama City, and Pensacola.

Trophy fish catches consisted of 25 white marlin, 5 sailfish, 2 dolphin, and

one wahoo. First prize for white marlin (71 pounds) was taken by Ed Chadbourne, aboard the *Caroline* of Pensacola; first prize for sailfish (52 pounds) went to Bob Bechtold, aboard the *Wahoo* of Destin; first prize for dolphin (34½ pounds) was awarded to Ted Jones, aboard the *Striker* of Shalimar, Florida; and first prize for wahoo (38¼ pounds) went to Bob Radcliffe, aboard the *Blusky Doodle* of Pensacola. First prize for a boat catch went to Captain Sonny Inscho (224½ points, based on points per pound for trophy fish), aboard the *See Spray* of Birmingham, Alabama.

First, second, and third place winners received their awards at a banquet held by the Pensacola Big Game Fishing Club on September 15.

What To Do About Military Explosives

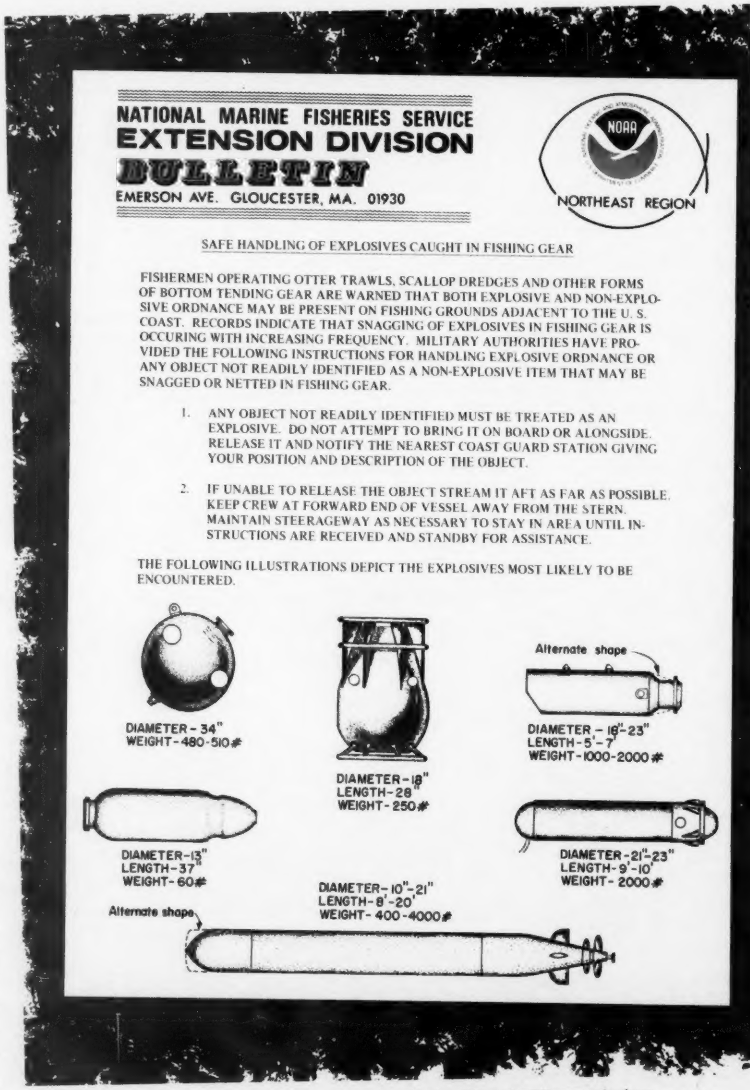
Fishermen operating otter trawls, scallop dredges, and other forms of bottom tending gear, are warned that both explosive and nonexplosive ordnance may be present on fishing grounds adjacent to the U.S. coast. Records indicate that snagging of explosives in fishing gear is occuring with increasing frequence.

Military authorities have provided the following instructions for handling explosive ordnance, or any object not readily identified as a non-explosive item, that may be snagged or netted in fishing gear.

1. Any object not readily identified must be treated as an explosive. Do not attempt to bring it on board or alongside. Release it and notify the nearest Coast Guard station, giving your position and description of the object.

2. If unable to release the object, stream it aft as far as possible. Keep crew at forward end of vessel away from stern. Maintain steerage as necessary to stay in area until instructions are received, and standby for assistance.

These are the instructions provided, with some illustrations (right), on the National Marine Fisheries Service's new safety information placard, "Safe Handling of Explosives Caught in Fishing Gear," now available from NMFS Regional Offices, or from the NMFS Extension Division, Washington, D.C. 20235. The placard is the third in a series of safety placards initiated by the Extension Program. The first two placards describe "Medical Assistance Available to Vessels," and "Helicopter Evacuation."


NATIONAL MARINE FISHERIES SERVICE
EXTENSION DIVISION
BULLETIN
EMERSON AVE. GLOUCESTER, MA. 01930

NOAA
NORTHEAST REGION

SAFE HANDLING OF EXPLOSIVES CAUGHT IN FISHING GEAR

FISHERMEN OPERATING OTTER TRAWLS, SCALLOP DREDGES AND OTHER FORMS OF BOTTOM TENDING GEAR ARE WARNED THAT BOTH EXPLOSIVE AND NON-EXPLOSIVE ORDNANCE MAY BE PRESENT ON FISHING GROUNDS ADJACENT TO THE U. S. COAST. RECORDS INDICATE THAT SNAGGING OF EXPLOSIVES IN FISHING GEAR IS OCCURING WITH INCREASING FREQUENCY. MILITARY AUTHORITIES HAVE PROVIDED THE FOLLOWING INSTRUCTIONS FOR HANDLING EXPLOSIVE ORDNANCE OR ANY OBJECT NOT READILY IDENTIFIED AS A NON-EXPLOSIVE ITEM THAT MAY BE SNAGGED OR NETTED IN FISHING GEAR.

1. ANY OBJECT NOT READILY IDENTIFIED MUST BE TREATED AS AN EXPLOSIVE. DO NOT ATTEMPT TO BRING IT ON BOARD OR ALONGSIDE. RELEASE IT AND NOTIFY THE NEAREST COAST GUARD STATION GIVING YOUR POSITION AND DESCRIPTION OF THE OBJECT.

2. IF UNABLE TO RELEASE THE OBJECT STREAM IT AFT AS FAR AS POSSIBLE. KEEP CREW AT FORWARD END OF VESSEL AWAY FROM THE STERN. MAINTAIN STEERAGEWAY AS NECESSARY TO STAY IN AREA UNTIL INSTRUCTIONS ARE RECEIVED AND STANDBY FOR ASSISTANCE.

THE FOLLOWING ILLUSTRATIONS DEPICT THE EXPLOSIVES MOST LIKELY TO BE ENCOUNTERED.

NMFS safety information placard on the handling of military explosives.

Columbia Coho Show High Dollar Return

Coho salmon production in the Columbia River Fisheries Program returns seven dollars in benefits to the economy for each dollar spent, according to an analysis by the Commerce Department's National Oceanic and Atmospheric Administration. NOAA's National Marine Fisheries Service administers funds for 21 Columbia River fish hatcheries operated by the States of Washington and Oregon and the Bureau of Sport Fisheries and Wildlife in the Department of the Interior.

To find out what the taxpayer is getting for the nearly $40 million spent on Columbia River salmon and steelhead hatcheries over the past 22 years (presently $2.5 million annually) the Fisheries Service analyzed data gathered by marking a known proportion of hatchery fish with a finclip or combination of finclips. The number of marked fish caught was then used to determine the hatchery contribution to each fishery. Values of the fish released by the hatchery were compared with the cost of rearing fish to determine the benefit-cost ratio.

A similar analysis of the data from hatchery contributions of fall chinook is nearly complete. Preliminary estimates indicate that for every dollar spent rearing fall chinook in Columbia River hatcheries, the Pacific coast economy gained at least three dollars. The benefit-cost ratios for the two species are not directly comparable because of different time periods and methods used to determine value, but the ratios provide fisheries personnel with solid indications of the value of the hatchery program to the Pacific coast.

The NMFS is now conducting a marking study to determine the contribution of Columbia River spring chinook salmon to the fisheries. Little is known about the hatchery contribution of this species to the marine and freshwater sport and commercial fisheries. This study is important as spring chinook represents about 20 percent of the 2.6 million pounds of smolts (young fish) released annually from NMFS-financed Columbia River hatcheries.

Foreign Fishery Developments

Troubled Icelandic Fisheries Produce

Despite territorial waters disputes and a volcanic eruption that closed several of its best fish processing facilities, Iceland's 1972 fish catch, 739,000 metric tons, was the highest since 1967 (Table 1), and the value of exports, $141 million (Table 2), marked a new high, according to Salvatore Di Palma, Regional Fisheries Attache for Europe, U.S. Embassy, Copenhagen, Denmark.

A 52 percent increase in the catch of low-value capelin, however, accounted for most of the 1972 increase and landings of the higher-valued cod were again down to 1968 levels. Most of the cod was taken in Icelandic waters; some was taken off East Greenland and the set-net fishery of March and April accounts for a major part of the landings.

Of Iceland's $141 million exports, the U.S. took 40 percent by value, primarily frozen cod fillets and blocks, and the nine members of the European Economic Community (EC) took 25 percent (Table 3). In quantity, exports were up three percent to 281,944 metric tons. A doubling of frozen scallops exports, mostly to the United States, indicates a high level of interest in expanding this previously unutilized fishery resource. High U.S. prices triggered Icelandic interest in scallops.

Table 1.—Icelandic catch of fish and shellfish, 1969-1972[1].

Species	1969	1970	1971	1972	Jan-Dec '71	Jan-Oct '72
	- - - 1,000 metric tons - - -				- - - US$1,000 - - -	
Demersal						
Cod	287	308	255	232	28,354	30,132
Haddock	35	32	32	29	5,128	4,411
Saithe	54	64	60	60	5,676	5,280
Ocean perch	29	25	32	33	3,694	3,914
Ling	9	8	9	[2]	857	614
Plaice	11	8	7	[2]	1,310	691
Greenland halibut	6	7	5	[2]	757	691
Other demersal	20	22	21	45	1,891	2,140
Total demersal	451	474	421	399	47,667	47,873
Pelagic						
Herring	47	41	61	43	9,520	5,498
Capelin	171	192	183	278	3,256	4,386
Shellfish						
Lobster (*Nephrops*)	3.5	4.0	4.7	4.3	2,421	3,296
Shrimp	3.3	4.5	6.5	5.0	1,477	1,071
Scallop	0.4	2.4	3.7	6.5	387	885
Other	3	6	4	3	818	141
Total	688.2	733.9	683.9	738.8	65,546	63,150

[1] Source: AEGIR, Nr. 17-18, October 1972.
[2] Included in "Other demersal."

Table 2.—Icelandic exports of fish and shellfish. 1971 and 1972, from the Statistical Bureau of Iceland.

Product	1971		1972	
	Metric tons	US$ 1,000	Metric tons	US$ 1,000
Fresh herring[1]	33,986	22,085	31,738	27,178
Other fresh fish[2]	47,879	7,072	38,010	6,144
Frozen fillets and blocks	18,359	4,631	16,786	4,617
Other frozen fish	69,533	58,294	67,234	60,530
Salted and dried fish[3]	13,833	3,429	12,659	4,185
Frozen lobster (*Nephrops*)	1,120	4,988	1,329	6,955
Frozen shrimp	1,110	3,249	1,221	3,683
Frozen scallops[4]	362	1,012	739	2,850
Canned fish	1,116	2,035	1,362	2,637
Cod meal[5]	29,622	5,469	27,607	5,442
Capelin meal	26,825	5,218	42,212	7,118
Other fish meal	5,392	883	5,699	1,236
Fish oil[6]	7,421	1,694	13,354	1,707
Other	17,187	6,878	21,994	7,128
Total	273,745	126,937	281,944	141,410

[1] Landed directly in Denmark for human consumption.
[2] Landed directly in the United Kingdom and Western Germany.
[3] Cod and other demersal species.
[4] Includes negligible amount of fresh scallops.
[5] Meal from offal.
[6] Except fish liver oil.

Table 3.—Icelandic exports of fish and shellfish in 1972, by major destination.[1]

Destination	Exports			
	Metric tons	Per cent	US 1,000	Per cent
West Germany	17,807	6	9,137	7
Other EC (6)	16,764	6	6,083	4
Total EC (6)	34,571	12	15,220	11
United Kingdom	41,617	15	11,880	8
Denmark	45,098	16	8,655	6
Total EC (9)	121,286[2]	43	35,755[2]	25
United States	49,315	17	56,198	40
Soviet Union	18,770	7	11,754	8
Other	92,572	33	37,707	27
Total	281,943	100	141,414	100

[1] Source: Statistical Bureau of Iceland.
[2] Includes exports to Ireland.

The volcanic action on Heimaey Island, closing several fish processing facilities, was a setback to Iceland's fish processing capacity. However, catch losses were minimized because the Heimaey based fleet fished out of other ports and delivered their catches to processing plants in mainland ports.

Iceland's fishing fleet consists of three main groups: (1) high-seas trawlers, (2) multipurpose vessels of more than 100 GRT, and (3) multipurpose vessels under 100 GRT. The number of trawlers in operation has decreased since 1960 to about 22 vessels in 1971. Most of the vessels withdrawn from the fleet were over 20 years old. The number of multipurpose vessels of over 100 GRT has increased significantly. During the latter part of 1972, delivery began of the 34 new stern trawlers ordered from foreign yards.

The changes in the fleet represent an increased and more efficient trawling capacity. In the face of predicted lower stock abundance for the near future on the Icelandic grounds, the industry expected to utilize the extra capacity on resources which it hopes to be available from reduced fishing by foreign vessels inside Iceland's newly claimed fishery limits.

On September 1, 1972, Iceland extended its fishery limits to 50 nautical miles. Efforts to reach an understanding with the two major foreign fleets, the United Kingdom (U.K.) and the Federal Republic of Germany, on fishing inside the new limits failed, and the matter has been strongly contested. The dispute has held up implementation of a trade agreement reached between Iceland and the EC. An agreement was reached with Belgium and the Faroe Islands whose fishermen have a modest fishing effort on the Icelandic grounds.

The waters around Iceland have been fished in recent years mainly by Iceland, the U.K., and West Germany. These countries catch 98 percent of the total catch of cod from Iceland grounds. Iceland takes 60-70 percent of the total catch. The U.K. catch has been about 25 to 30 percent and West Germany's, 5-7 percent. The cod fishery can be considered as two sectors: the spring fishery for spawning cod off the southwest coast consists of largely Icelandic vessels, and that around the island year around for nonspawning cod, when Iceland's fleet is joined by trawlers from other countries, mainly working on the immature cod.

Annual production of cod has varied around 390,000 metric tons since 1960. From 1964 to 1967, the catch declined from 434,000 tons to 345,000 tons, owing to the absence of good year classes in the spawning fishery. Since then, a good 1964 year class and several good year classes which had migrated to Iceland from East Greenland raised the catches to 471,000 tons in 1970, the high level since 1960. Since 1970 the catch has declined.

Source: NMFS Foreign Fisheries Leaflet 73-17.

Danish Fish Catch Continues to Climb

Over the last decade the Danish fish catch has doubled and the catch value continues its upsurge, reports Salvatore Di Palma, Regional Fisheries Attache for Europe, United States Embassy, Copenhagen, Denmark. Landings of fish and shellfish reached record levels in 1972—1,416,800 metric tons in quantity and US$144 million in value. Exports also set record levels, includ-

ing a 26-percent rise in value to US$271 million.

The United States took products worth US$34.8 million, double the 1971 value, mostly in frozen cod fillets and blocks. The Faroese catch was down slightly to 200,000 tons, but the value of exports was up 14 percent. Greenland landings were 42,500 tons, 11 percent higher than 1971. The marked expansion of the Danish fisheries is to a large extent due to development of its industrial fisheries and the production of cod.

Entry into the European Economic Community (EC) is bringing changes to the Danish fisheries. Regulations are being revised to comply with the EC fisheries policy. On April 1, 1973, EC duty levels were reduced 20 percent for Danish products in a market which took nearly half the Danish exports of fish and shellfish in 1972. Danish duties will change, mostly rising, by 40 percent of the difference between the EC level beginning in January 1974; U.S. exports will be negatively affected.

Development of a position on fishing limits for the UN Law of the Sea Conference is complicated by differences between Denmark proper and its outlying areas. The Greenlanders and Faroese favor a 50-mile fishing limit whereas Denmark is satisfied with 12 miles.

Two major conservation measures were adhered to during 1972—one phasing out fishing for salmon on the high seas in the Northwest Atlantic while guaranteeing Greenland fishermen a quota for salmon taken in Greenland waters, and the other restricting North Sea herring fishing during February 1 to June 15, 1973.

Source: NMFS Foreign Fisheries Leaflet 73-20.

Japanese To Fish Madagascar Shrimp

Four major Japanese fishery firms are focusing attention on the skipjack resource off Madagascar (Malagasy Republic) in the western Indian Ocean according to Japanese news reports. Those firms—Taiyo, Nichiro, Kyokuyo and Kaigai Gyogyo—are planning to form joint ventures with Madagascar interests for the development of skipjack fishing grounds northwest of that country.

Kaigai Gyogyo, which has previously fished off northwestern Madagascar with good results, shortly plans to obtain permission to establish a joint fishing company for operation of the 1,000-gross-ton mothership "Seishu Maru No. 18" and eight 150-ton bait boats. From February to December 1972, that firm surveyed the waters off the Comoro Islands with three bait boats, which averaged catches of about 15 tons per boat per day. Baiting grounds inside the territorial waters were used with the permission of the Madagascar government.

Nichiro hopes to shortly obtain permission to conduct fishing preliminary to forming a joint venture with local interests. That firm plans to send the pole-and-line vessel "Kuroshio Maru No. 72" (240 gross tons) to Madagascar, and if results are favorable, it hopes to send more boats.

Kyokuyo has been exploring the waters northwest of Madagascar with "Daido Maru" (199 gross tons). The catch has been averaging over six tons per day. Because of the profitable outlook, Kyokuyo has decided to form a joint venture this fall and plans to employ 5-10 Okinawan vessels.

Taiyo, which is planning to venture into joint shrimp fishing in Madagascar, also hopes to develop a skipjack fishery in that region. It plans to conduct experimental fishing off the Comoro Islands, utilizing the baiting ground around Nosy Be Island.

Peru Will Develop Food Fish Industry

The phenomenal growth of the anchoveta fishing industry in Peru has tended to obscure the complexity of that country's long-term fisheries development program, according to a paper to be presented at the forthcoming world Technical Conference on Fishery Products being convened by the Food and Agriculture Organization of the United Nations (FAO), in Tokyo from December 4-11, 1973.

While the anchoveta account for about 98 percent of the Peruvian catch, upwards of 200,000 tons of food fish are caught yearly, including hake, bonito, skipjack, yellowfin tuna, crustaceans, and molluscs.

In the course of the development of the anchoveta fishery there was considerable industrialization. For example, there are now more than 100 plants established along the coast to convert the fish to meal and oil and the shipbuilding industry has expanded.

As part of its plans for the diversification and expansion in fisheries, the government established a Ministry of Fisheries in 1970, which has set up an organizational structure to cover all aspects of the industry. This includes a state organization to participate in the food fish industry, influencing "pricing and distribution policies, the infrastructure developed and assistance given to the cooperatives".

A doubling of food fish production is called for in the Ministry's Five Year Plan (1971-76). Included in the expansion plans are 16 fish terminals and 12 inland fish distribution depots, which are expected to be completed this year. The infrastructure is being developed to give more help to the artisanal fishermen and a sales network is being established in the Sierra to provide the local people with fish to add more protein to their diet. Further, a modern million dollar fish terminal has replaced the old pier at Callao and the Lima Wholesale Fish Market has been rebuilt, to be supplemented by a number of smaller, decentralized markets. Fresh fish are now being distributed in 100,000 42-liter boxes.

In vessel construction, 40 fishing

boats of 50-foot length were launched in 1972, another 80 were planned for 1973 with 100 more to follow in 1974. The Ministry is also concerned with converting surplus anchoveta fishing boats for use in the food fish industry. In an effort to improve quality standards, the Ministry has established a fish inspection service.

The paper on Peruvian fisheries development is by W. Philip Appleyard, manager of the UNDP-FAO fish marketing and utilization project in Peru. The project is chiefly concerned with fish marketing and utilization and has been closely associated with all the Peruvian fishery development activities in recent years. Appleyard also points out that some of the vast catch of anchoveta might be used for human consumption: "In addition to canning, possibilities are being explored for freezing, drying and salting the fish and a food target of several thousand tons of anchoveta should be achievable within the next two or three years."

Canada To Conserve, Study Bluefin Tuna

Fishing lines heavier than 130 pounds test have been prohibited in Canada's Gulf of St. Lawrence bluefin tuna sport fishery, Fisheries Minister Jack Davis has announced.

The move is intended to prevent overfishing of large, mature tuna stocks in the Gulf area. The 130 pound-test line is the standard maximum game fish tackle approved by the International Game Fish Association.

"This conservation measure reinforces action taken in 1972 to prohibit commercial fishing for tuna in the Gulf of St. Lawrence," Mr. Davis said. "We cannot allow tuna stocks to be over-fished."

Sport fishing for tuna in Gulf waters is centered in Prince Edward Island where landings have increased by more than 400 per cent during the last three years. Anglers' catches rose from 99 in 1970 to 482 last year.

Canadians Urged To Catch Atlantic Fish

Canadian Fisheries Minister Jack Davis has asked Canadian fishermen to catch more fish in the North Atlantic.

Quotas for more than 20 different stocks were set by the International Commission for the Northwest Atlantic Fisheries (ICNAF) at its annual meeting in Copenhagen, Denmark, in June. Canada's allotment was increased by 50,000 metric tons. Its estimated landed value is $8 million and processed value, $20 million.

"Canada's larger share is in waters fished by Canadians for years, mainly off southern Labrador, Newfoundland and Nova Scotia," Mr. Davis said.

In return for higher allocations of cod and herring, Canada accepted a reduction in species in which Canadians have little or no interest—for example, silver hake on the Nova Scotia Banks.

Canada's share of cod catches in the areas under ICNAF quota for 1973 will total 193,000 metric tons, 80,000 more than Canadians took in these areas in 1972.

In the Labrador-Eastern Newfoundland area, the Canadian allocation is 110,000 tons, compared to a 1972 catch of 66,000 tons.

Norway Fish Exports Rise, Labor Drops

Norwegian exports of fish and fish products in the first 6 months of 1973 went up in value by 19.3 percent to 1,476 million kroner (about $264 million) compared with the first 6 months of 1972, according to *Norway Trade News*.

The biggest increase has been the export value of fish meal, which earned 380 million kroner, a 77.8 percent increase in the corresponding period last year, although the export quantity increased by only 7.3 percent to 181,000 tons. Exports of fish oil earned 59 million kroner and exports of hardened marine fats 77 million kroner.

Meanwhile, the Norwegian frozen fish marketing organization Frionor, in Oslo, reports that exports worth between 30 and 40 million kroner (about $6 million) have been lost this year due to a shortage of workers in the processing plants, particularly in North Norway. Fish prices on the world market are very favorable at present, and supplies of fish, chiefly cod, haddock and saithe, have also been good, says Frionor's Managing Director Arne Asper. Further "mechanization of production" is believed a key to making the fish processing industry work more attractive.

Ireland Sets Record For 1972 Fish Season

During 1972, Irish landings of herring and other pelagic species rose sharply and offset a decline in landings of cod, haddock, and other demersal species. Total value of marine fish and shellfish reached a record US$12.5 million compared with US$10.8 million in 1971, according to Salvatore Di Palma, Regional Fisheries Attache for Europe, United States Embassy, Copenhagen, Denmark.

As usual, herring was the leading species accounting for 40 percent of the marine catch by value and the 1972-73 winter herring season was the most valuable ever. Despite lower landings, cod, haddock, and plaice were the main demersal fish taken. Various species of lobsters also were important in the Irish catch, accounting for US$2.3 million or 18 percent of the total. The salmon catch, not included under marine landings, was valued at an estimated US$4.9 million, up from US$3.3 million the previous year.

Herring, salmon, and lobster products contributed to record fishery

exports valued at US$18.6 million. The United Kingdom continued to be the largest market, taking US$6.8 million worth, or 36 percent. During 1972 Irish exports of fresh and preserved herring reached the highest level in more than 20 years, totaling 37,187 metric tons, up 33 percent from 1971 and valued at US$8 million. Imports also rose and were worth US$8.7 million; fish meal and canned salmon were the main items.

Outlook for the future is for continued expansion and higher exports, though difficulties forseen include insufficient personnel and increased competition from foreign fishermen. Despite recent growth Irish fishermen still take only an estimated 15 percent share of the resources in nearby waters.

The Irish fishing fleet is still primarily an inshore fleet, comprising small to medium fresh-fish vessels which stay out less than 24 hours as a rule. In 1973, the fleet of vessels with inboard engines included 30 vessels over 75 GRT, 245 vessels from 26-75 GRT, and 732 craft 25 GRT and under.

The Irish fish and shellfish processing industry is marked by new facilities, found all along the coast. These range from plants producing frozen and cured products to holding ponds for shellfish. The processing side, like the fishing side, is still noteworthy by the absence of large-scale, integrated, industrialized operations found in neighboring countries.

Five major fishing centers—Killybegs, Galway, Dunmore East, Howth, and Castletownbere—are envisioned in government fishery development plans; work is well along at these, as well as at lesser fishing ports along the Irish coast.

Ireland claims three-nautical-mile territorial waters and exclusive fishing rights between 3 and 12 miles. Several countries have traditional fishing rights to certain stocks in the 6- to 12-mile zone. European Economic Community (EC) countries have fishing rights inside the 6- to 12-mile zone along specified areas of the coast.

Entry into the EC required a reorientation of industry goals and changes in regulations. Although some opposition was voiced against entry, advantages in marketing and other areas are believed to outweigh possible competition inside the Irish 6- to 12-mile fishing zone.

Another potential troublespot may arise if large EC and other European vessels, now being eased out of areas like the Icelandic and North African fishing grounds, decide to fish waters off the Irish coasts more extensively.

Source: NMFS Foreign Fisheries Leaflet No. 73-18.

Japan Tests Isotope "Tagging" of Salmon

Japanese scientists have developed a method to identify the birthplace of a salmon by using activation analysis in which a nonradioactive element made radioactive is mixed in the feed given to young salmon. When the grown fish is caught a few years later, the element which has been concentrated in the fish's scales over the years would be detected in the activation analysis. Japan hopes to use the method to settle disputes over the birthplace of salmon raised in fishery talks with the Soviet Union. After a successful experiment at a fishery station, the Japanese Agriculture-Forestry Ministry plans to test the method next spring using 45 million young salmon released in the Nishibetsu River in Hokkaido. The element to be used is europium.

Canada Eyes Atlantic Fish Vessel Policies

A thorough review and assessment of Canada's Atlantic fishing fleet development programs, leading to the introduction of new licensing and vessel construction subsidy policies has been announced by Fisheries Minister Jack Davis. The objective is to achieve orderly development of the fishing fleet on the Atlantic coast and to ensure that catching capacity does not greatly exceed available fish resources.

Pending the results of the review, an immediate three-month freeze has been placed on construction subsidies available under the Fishing Vessel Assistance Regulations for craft 35 to 75 feet in length. During the same period, departmental approval will be withheld for construction of larger fishing vessels under the Ship Construction Subsidy Regulations administered by the Department of Industry, Trade and Commerce. The freeze on subsidies applies throughout Canada.

Mr. Davis said there has been intensified interest in fishing vessel construction in recent months, particularly on the east coast. This trend has been encouraged by unprecedented high returns for fish and prospects for an expanding share of the international North Atlantic catch under International Commission for the Northwest Atlantic Fisheries (ICNAF) quotas. The possibility of an improvement in Canada's fishing position stemming from decisions that may be reached at the upcoming UN Law of the Sea Conference is another factor.

He said current applications for vessel construction subsidies already

exceed the funds allocated for this purpose in 1973-74.

"The prospects for increased fish catches by Canada in the future are good" said Mr. Davis. "But while we are asking our fishermen to go out and catch more fish, we must plan for a controlled development of the fleet and avoid short-term overcapitalization which would dilute the benefits that our fishermen, shoreworkers and processors would otherwise gain from increased catches.

"What we want to do, in effect, is to tailor the capacity of our fleets to the quantities of fish available to Canadian fishermen" he added. New vessels that have been approved for subsidies will not be affected by the three-month freeze.

Mr. Davis explained that when the new licensing scheme is implemented in the Atlantic region, vessels already fishing or for which firm commitments had been made for acquisition prior to this announcement will be granted licenses, providing they meet existing regulations. Licensing of new entries to the fleet beyond this point will be considered in the light of the new policy.

An overall license plan for commercial fishing boats on the Pacific coast has been in existence for several years.

The policy review involved full consultation with the provincial governments concerned and with the fishing industry.

European Investment Bank Funds Trawlers

The European Investment Bank (EIB) has granted to Reederei Sohl of Bremerhaven (run in conjunction with Hanseatische Hochseefischerei AG) a loan of DM 17.7 million (US $7.335 million)[1] for 14 years at a yearly interest rate of 7¾ percent. This partnership of shipping companies, which combines the Oetker group's fishing interests, is the second largest fish producer in West Germany holding 30 percent of the fresh fish market and 20 percent of that for frozen fish products.

The bank's loan will be used for the purchase and operation of two refrigerated trawlers with the most modern design and equipment. They are part of an order for four ocean-going vessels (placed with Seebeck-Werft of Bremerhaven), being built under a Government-approved program set up by various shipping companies in West Germany and the German Deep-Sea Fishing Federation. The program provides for the construction of 14 vessels with a total gross tonnage of 50,000; it takes into account the quotas fixed by international fishing agreements and will not bring about any substantial increase in the fleet's catching capacity, but it is mainly intended to provide replacement and rationalization investment which will help to restructure the West German deep-sea fishing industry. Like the corresponding program in other EEC countries, its main objective is to adapt supply to the long-term trend of demand and to guarantee adequate supplies to the market by increasing production of frozen fish. The consumption of frozen fish has been rising steadily in all EEC countries for several years and should continue to do so in the future, unlike that of fresh fish.

The financing by EIB of this project, which in all will cost about DM 46 million (US$19,165 million)[1], is in line with its task of financing modernization and conversion projects and ties in with the EEC's policy on fishing.

[1] Exchange rate as of July 27, 1973.

Source: Press Release, EIB, July 19, 1973.

Fish Nomenclature Trips New Zealand

Nomenclature appears to be troubling New Zealand exporters, reports the Worldwide Information Service. For some time now, they have been negotiating with the U.S. Food and and Drug Administration (FDA) to allow "New Zealand Snapper" to enter and be marketed in the U.S. under that name. To date, FDA has refused, despite the fact that "New Zealand Snapper" is acceptable to Australia, Japan and the Food and Agricultural Organization of the United Nations (FAO).

The basis for FDA's refusal is that the species called "New Zealand Snapper" (*Chrysophrys auratus*) is a member of a group known as "porgies" in the United States. FDA has no objection to the product if labeled "New Zealand Porgy".

Canada Subsidizes Fish Meal Industry

A $10 million purchase program for fish meal under the provisions of the Fisheries Prices Support Act has been announced by Canada's Fisheries Minister Jack Davis.

Under the program, the Fisheries Prices Support Board will offer to purchase fish meal from Canadian producers who may find themselves in difficulty due to the federal government's recently imposed export embargo on the product. Companies who sell fish meal to the Board will have the right of first refusal to re-purchase for resale at a later date.

Canada exported 36,000 tons of fish meal in 1972, valued at approximately $7 million. Chief markets are the United States and Britain. In recent years, successful purchase programs to stabilize the market have been operated by the Fisheries Prices Support Board for such commodities as groundfish and Lake Erie yellow perch.

Dredge Spoils Not Seen Hurting R.I. Scup

Newport and Sakonnet, Rhode Island trap fishermen have caught fewer fish over the past few years owing to a regional decline in scup—the most important trap fish—and probably not because of dredge spoil dumped nearby in Rhode Island Sound, according to University of Rhode Island marine biologists.

The researchers reported finding no evidence that spoil dumping has hurt local fisheries in their study, recently completed for the New England Division of the U.S. Army Corps of Engineers.

The report, "Dredge Spoil Disposal in Rhode Island Sound," is the third completed by URI scientists monitoring the impact of some 9.35 million cubic yards of spoil—dredged mainly from the Providence River and also from Brayton Point, Mass., and Point Judith—that was dumped in an area four miles south of Newport, mainly between late 1968 and early 1971.

Other assessments made by the URI biologists include:

- Levels of such contaminants as mercury, lead, and petroleum products remain low in the dump area and appear to present little public health hazard.
- Although the one square mile dump area has been partially recolonized by marine animals, progress is slow. Colonization, at the present rate, may not be complete until 1984. The report noted a "relative paucity" of tiny marine life valuable for fish food at the center of the dump site.
- No evidence of cloudy, turbid waters was found in the vicinity of the dump site, though seasonal turbidity and the effects of storms need to be understood, before the spoil effect on turbidity can be fully ascertained.

Cloudy, turbid waters would not be likely to kill scup, the biologists asserted. Many Rhode Island trap fishermen believe, however, that scup have been repelled from their traps by turbidity which, the fishermen feel, originates at the dump site.

The URI report stated that scup fisheries have recently declined along the coasts of Connecticut, New Jersey, New York and Virginia. The decline in Rhode Island scup landings began two years before spoil dumping, after a peak catch of approximately 4,055 tons in 1965. The Rhode Island catch fell to 620 tons in 1969 and recovered to 929 tons in 1971. This is not the first time the scup fisheries have declined, the biologists said. The report of the U.S. Commission of Fisheries for 1871-1872 discussed a similar decline.

The scientists reasoned that since little scup trawling was done at the site prior to dumping, it is unlikely the area was important for scup spawning or feeding. Young scup fry usually congregate in very shallow water, so it is not likely that the dump site was a nursery area, they said.

During field studies, the scientists found as many as 30 to 40 species of marine animals in sampled areas of the site. The lowest number of species was found in the dump area and the highest number on "natural" sediments bordering the dump site.

A small marine worm considered to be a "pollution indicator" was found on the spoil, but in smaller numbers than usually found in seriously polluted coastal bays.

Texas Sportfishermen Break Three Records

Three new Texas marine sportfishing records, for barracuda, jewfish, and hammerhead shark, were established late last summer.

An 870-pound hammerhead shark, landed at the Seven Mile Oil Rig off Port Aransas, by Ross Havard, Portland, bested the old record by 360 pounds. It was 173 inches long, had a 73-inch girth, and was taken on a 130-pound test line. The new jewfish record, a 630 pounder measuring 88 inches long and 68 inches in girth, was shot with a pneumatic spear gun by Jim Frith, Corpus Christi, near a gas-producing platform three miles off Mustang Island.

The largest barracuda landed in Texas waters is now Tom Stahl's 36 pounder, taken offshore near Port O'Connor. The trophy was 55 inches long, 21½ inches in girth, and added three pounds to the previous record.

Speckled Trout Are Successfully Spawned

A combination of good physical condition, proper water temperature, and hormone injections paid off with almost 200,000 larval speckled trout for marine biologists of the Texas Parks and Wildlife Department recently. Biologists say that knowledge gained from the successful spawning of the five female trout will give them a greater understanding of the species' reproductive requirements. The research may also be applicable to other species.

Of special interest to biologists are factors involving reproduction, and the ability to produce speckled trout makes comparative trout reproduction studies possible. The successful hatch was accomplished at the Department's Marine Fisheries Research Station in Palacios.

Biologists say speckled trout are delicate fish, and many past spawning failures can be traced to the fishes' poor condition due to normal handling during capture. The five trout for the successful spawn, ranging from ¾ to one pound, were taken on hook and line. Biologists say they have found that this method is easier on the fish than trawls and nets.

Approximately 150,000 of the young trout were placed in a one-third

acre pond to be reared. The rest of the fish will be used in laboratory experiments involving water temperatures and different types of food.

Bering King Crab Catch Record Set

Fishermen caught a record 27 million pounds of king crab in the Bering Sea this year, reports the Alaska Department of Fish and Game. The catch was more than five million pounds greater than the previous maximum harvest in 1972 and returned nearly $16 million to the 65 boats involved in the fishery.

The Board of Fish and Game had set a quota of 23 million pounds of king crab in the Bering Sea for the period beginning June 15 and the area was closed on Sept. 9 when the quota was filled. The other four million pounds had been caught before the quota period began. Bering Sea fishermen have also landed about 300,000 pounds of tanner crab and the area remained open for fishing of this species.

An increase in the number of legal crabs per pot lift indicates that fishing success was higher in 1973 than it has been in previous years. Department biologists say that this may indicate that king crab populations have increased somewhat following a decline from 1966 to 1969 and a period of stable, low abundance from 1970 to 1972. However, the fleet is becoming increasingly mobile each year and is now harvesting king crab stocks in areas where the species has not been fished before.

Publications

University of Rhode Island Publications

The following is a list of recent publications available frm the University of Rhode Island Marine Advisory Service. To order the publications direct, make requests to Marine Advisory Service, University of Rhode Island, Narragansett Bay Campus, Narragansett, RI 02882. Make all checks payable to the University of Rhode Island.

"Ecology of Small Boat Marinas," Technical Report No. 5—Order Number P-165, is a 20-page report written by Dr. Scott Nixon, Dr. Candace Oviatt and Sharon Northby, marine biologists at URI's Graduate School of Oceanography. Their principal conclusion: marshes and marinas seem able to peacefully coexist. Much of the same kind of animals and plants that flourished in the marsh also flourished in the marina. The authors have several recommendations on siting and management. $1.00.

"Chartwork for Fishermen and Boat Operators, " Marine Bulletin No. 10—Order Number P-127, is an 86-page handbook that will enable commercial and sports fishermen or pleasure boat owners to learn or improve their proficiency in chartwork. A few of the subjects covered are reading of the chart, practical chartwork, how to steer a course to combat estimated current and wind, use of the marine sextant and use of soundings to estimate position. $3.00.

"Navigation for Fishermen and Boat Operators," Marine Bulletin No. 10—Order Number P-131, is designed to teach the basics of deep sea celestial navigation—plotting a course out of sight of land by knowing positions of the moon, sun or stars. The text continues where Chartwork for Fishermen and Boat Operators, stops. The book is divided into two parts: one on principles of navigation and the other on practical problems including use of nautical tables. Seventy-five pages. $3.50.

"Fisheries Cooperatives: Their Formation and Operation", Marine Memorandum 30—Order Number P-136. This publication is based on a workshop of fisheries cooperatives, held spring (1972) at Galilee, RI. Topics cover how to organize and finance a fisheries cooperative; role of the manager; marketing agreements technical operations; and community relations. Several New England fisheries cooperatives are discussed. Eighteen pages. Free.

Recent NMFS Scientific Publications

NOAA Technical Report NMFS CIRC-378. Borror, Arthur C. **"Marine flora and fauna of the northeastern United States. Protozoa: Ciliophora."** September 1973. 62 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price: 65 cents.

ABSTRACT

This manual includes an introduction on the general biology, an illustrated key, an annotated systematic list, a selected bibliography, and an index to the marine ciliated Protozoa of coastal and estuarine waters of New England. The key facilitates identification to family of nonencysted, nondividing marine ciliates at any stage in the life cycle.

NOAA Technical Report NMFS SSRF-670. Van Meter, Harry D. **"Unharvested fishes in the U.S. commercial fishery of western Lake Erie in 1969."** July 1973. 11 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Price: 25 cents.

ABSTRACT

Potential commercial fish production was estimated for U.S waters of western Lake Erie in 1969 from pounds landed and pounds

discarded. Periodic observations of catches in haul seines and trap nets revealed that about 37 percent of the catch (by weight) in haul seines and 26 percent of that in trap nets were low-value fishes that were discarded. Projection of these discarded catches to include the total fishing effort indicated that an additional 2.8 million lb of low-value species would have been landed in 1969 if a reasonable profit had been assured. It is concluded that the sustained yield could be increased considerably with only a moderate increase in fishing effort.

NOAA Technical Report NMFS SSRF-671. Bakun, Andrew. **"Coastal upwelling indices, west coast of North America, 1946-71."** June 1973. 103 p. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

ABSTRACT

A series of monthly indices of intensity of large-scale, wind-induced coastal upwelling at selected locations along the west coast of North America is presented for the period 1946 through 1971. The indices are based on calculations of offshore Ekman surface wind transport from monthly mean surface atmospheric pressure data. Summaries by quarter and by year are included.

The effect of using monthly mean pressure data is evaluated by comparison to a similar series of monthly means of transports computed 6-hourly over a 4½-yr period. The correlation between the two series at any particular location was found to be high. However, the slope of the regression line varies at different locations. Also values off southern California during summer may be amplified relative to other locations as a result of the discontinuity in the atmospheric pressure gradient caused by the coastal mountain range between the thermal low in the interior of southern California and the higher pressure offshore. The conclusion is that these series may be satisfactory indicators of temporal variations of upwelling at each location, but less satisfactory indicators of spatial distributions.

Book Review

New FAO Fisheries Science Manual

Reviewed by JOSEPH PILEGGI

"Manual of Methods for Fisheries Resource Survey and Appraisal" (Part 2. The Use of Acoustic Instruments for Fish Detection and Abundance Estimation). FAO Manuals in Fisheries Science No. 5. Edited by S. T. Forbes and O. Na-ken. Food and Agriculture Organization of the United Nations, Rome, Italy, 1972; viii + 138 pages, illus. $4.00. Sold in the United States by Unipub, Inc., 650 First Avenue, P.O. Box 433, New York, NY 10016.

Acoustic methods for fish finding and commercial fishing operations have been a regular feature of most developed fishing fleets for over 20 years. Many advances and improvements have been made to enable the fishermen to use acoustic sounds and sonars to increase his catches and improve his chances of success. The use of these instruments for research by scientists, however, has only recently become commonplace.

This book covers the use of these instruments by fisheries scientists in making population estimates independently of fishery statistics of catch and effort and tagging experiments, and methods for rapid exploration of unexploited stocks. Increasing emphasis is being placed on the problems of direct and speedier estimation of fish populations, and methods of sizing and counting fish with echo-sounders and sonars. A summary of the state of knowledge in the use of acoustics for fisheries resource survey and appraisal is the principal purpose of this book. It aims at giving the fisheries scientist a thorough understanding of the basic theory involved in his use of underwater acoustics and in the more precise application of echo-sounders and sonars for abundance estimation. But it is not intended as a handbook on fish counting.

The book is divided into five sections. Section I deals with the physical properties of sound in water: its propagation and reflection from targets. Discussed are propagation of sound, formation of sound waves, sound intensity, reflection of sound in water, echo level, and target strength of fish. Section II discusses the structure and functioning of sonar equipment, and presents information on the basic features of sonar equipment, the echo sounder, the paper recorder, phasing, transmitter unit, transducers, and other details. Section III covers the identification of targets and characteristics of echo records. Section IV deals with abundance estimation and includes single fish echos, sampling volume, mean echo strength, multiple echos and scattering layers, vessel grading of echo recordings, and counting and sizing of echo recordings. The fifth and last section presents new developments in sonar techniques—gives some idea of the possibilities which might be within reach in the near future for estimating the amount of fish (in weight or number) within an area.

A preliminary version of the present book was issued in 1969 as FAO Fisheries Technical Paper No. 83—**"Manual of Methods for Fish Stock Assessment. Part 5. The Use of Acoustical Instruments in Fishing Detection and Fish Abundance."** It was based on the **"Report of the Fourth Session of the Advisory Committee on Marine Resources Research, 16-21 January 1967. Report of the ACMRR Working Party on Direct and Speedier Estimation of Fish Abundance,"** FAO Fisheries Reports No. 41, Suppl. 1. The preliminary book was used

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as the basis for lectures at several training centers. The present book is based on the experience gained at those centers and many parts have been updated to include the most recent developments and techniques. The large and international list of contributions gives an indication of the extent of this revision. This book will be a valuable asset to any fishery scientist and biological state engaged in population dynamics.

Monthly Fishery Market Review

July '73: Tightening Supplies and Higher Prices

The overall situation in the U.S. fishing industry during July was one of tightening supplies and generally higher prices. Only the major groundfish species supplies (Table 1) were significantly above the previous year. As a result of the shortening supplies, prices (Table 2) rose during the month for many species of fish and shellfish.

Table 1.—Groundfish supplies (fillet weight, in million pounds), July 1973. Groundfish include cod, flounder, haddock, and ocean perch.

	MAY 1973	JUNE 1973	JULY 1973	JULY 1972	Percent Change	JAN — JULY 1973	JAN — JULY 1972	Percent Change
	- - - Million Pounds - - -				Percent	Million Pounds		Percent
Beginning Inventory	31.1	34.5	42.6	17.8	+ 139	52.4	45.0	+ 16
Landings, Total	6.7	6.7	4.6	6.2	− 25	37.9	41.0	− 8
Imports	25.4	33.9	25.9	25.6	+ 1	174.1	146.0	+ 19
Total Supply	63.2	75.1	73.1	49.6	+ 47	264.4	232.0	+ 14
Ending Inventory	34.5	42.6	47.5	27.0	+ 76	47.5	27.0	+ 76
Consumption	28.7	32.5	25.6	22.6	+ 13	216.9	205.0	+ 6

Table 2.—Groundfish prices (wholesale, FOB Boston, Gloucester, and New Bedford), July 1973.

	MAY 1973	JUNE 1973	JULY 1973	JULY 1972	Percent Change	JAN — JULY 1973	JAN — JULY 1972	Percent Change
	- - - Cents Per Pound - - -				Percent	Cents Per Pound		Percent
COD								
Ex-vessel[1]	13.1	14.3	18.9	17.3	+ 9	19.9	20.0	—
Wholesale								
1 lb. Canadian	62.0	66.1	68.1	56.4	+21	61.3	54.9	+ 12
5 lb. Canadian	59.6	63.5	64.0	55.9	+ 14	57.0	54.1	+ 5
Retail[2]	174.5	170.6	170.0	124.0	+37	178.4	130.1	+37
FLOUNDER								
Ex-vessel								
Yellowtail	18.30	15.78	19.90	17.64	+ 13	23.97	20.06	+ 19
Lemonsole	24.84	28.57	52.00	39.09	+33	43.25	38.47	+ 12
Greysole	19.08	19.17	29.17	22.93	+27	29.11	25.57	+ 14
Blackback	17.91	18.48	30.02	25.07	+20	27.36	28.01	− 2
Wholesale								
5 lb. domestic	95.7	85.6	87.5	95.0	− 8	94.4	88.7	+ 6
5 lb. Canadian	80.2	80.0	81.8	66.3	+23	79.7	58.8	+36
Retail[2]	224.0	216.6	219.4	170.3	+29	189.5	162.7	+ 16
HADDOCK								
Ex-vessel[1]								
Large	44.5	40.8	49.5	42.4	+ 17	45.8	41.3	+ 11
Scrod	32.2	21.3	22.9	32.3	−29	27.2	33.3	− 18
Wholesale								
5 lb. Canadian	79.5	79.9	83.7	73.4	+ 14	79.3	62.6	+27
Retail[3]	128.7	132.2	133.6	105.3	+27	125.0	103.7	+21
OCEAN PERCH								
Ex-vessel[1]	7.5	7.5	7.6	5.7	+33	7.4	5.4	+37
Wholesale								
5 lb. domestic	63.0	59.3	58.0	46.3	+25	59.2	39.2	+51
5 lb. Canadian	55.4	55.5	55.8	43.1	+29	53.8	38.7	+39
Retail[3]	96.9	99.6	99.8	75.2	+33	94.3	73.6	+28

[1] Quotes taken at Boston, MA
[2] New York Consumer Market Reports
[3] Bureau of Labor Statistics—average of 36 U.S. cities.

BLOCKS, STICKS, AND PORTIONS

Fish sticks and portions producers continue to face a serious block shortage; even astronomical prices have not succeeded in attracting greater imports (Tables 3 and 4). Producers appear to be trying to build inventories of blocks in the absence of additional imports by cutting back severely on summer production of sticks and portions (Tables 5 and 6). Supplies of raw material are, nevertheless, well below last year and replacement prices for blocks are soaring—up to 69 cents per pound for cod in July with no signs of letting up.

With the price freeze over, producers are in a position to pass on block price increases; thus, we expect to see a sudden bulge in stick and portion prices when the blocks purchased this summer at higher costs go into production. U.S. production of blocks has risen sharply since last year, but this still represents a minute percentage of U.S. block requirements. The outlook for increased production of sticks and portions this fall, given the current block shortage, is bleak.

GROUNDFISH FILLETS

Supplies of major groundfish fillets (cod, flounder, haddock, and ocean perch) are still well above last year,

although the contribution of imports to this increase fell off during July (Tables 7, 8, 9, and 10). Cold storage holdings built up again in July for the fourth consecutive month as consumption seasonally declined. Even though U.S. catches are not faring too well this year with all major species below year ago harvests, total supplies are still more than adequate to support a healthy increase in fourth quarter consumption over 1972. Retail prices for all species were at least a fourth higher than July a year ago. Most ex-vessel and wholesale prices have exhibited similar increases; however, this price situation does not appear to have significantly deterred consumption. A decline in consumption from June to July is normal for this time of year.

CANNED SALMON

Alaska packers turned out slightly more than 1 million standard cases in 1973; poorest on record. The smaller can sizes were packed in greater quantities this year instead of the one-pounders as packers were apparently trying to spread their fixed costs over a greater number of units. Most supplies available for consumption appear already committed so that many markets are nearly void of product, even with prices held to ceiling levels. The price regulations have encouraged some cultivation of export markets where prices are not controlled. There will be no relief from the short supply situation until next year's canning season, and even then, prospects for a heavy pack are not good.

SHRIMP

The situation in the shrimp fishery during July was one of tightening supplies, rising prices, and reduced consumption (Tables 11 and 12). Supplies of shrimp totaled only 93 million pounds during the month—down a whopping 24 percent from the same month in 1972. With sup-

Table 3.—Supplies of blocks and slabs, July 1973.

	MAY 1973	JUNE 1973	JULY 1973	JULY 1972	Percent Change	JAN — JULY 1973	JAN — JULY 1972	Percent Change
	- - - Million Pounds - - -				Percent	Million Pounds		Percent
Beginning Inventory	32.4	32.3	33.1	62.9	−47	75.8	62.7	+ 21
Production	0.4	0.4	0.3	0.2	+50	2.8	1.2	+133
Imports	29.8	31.3	27.4	33.8	−19	171.2	215.4	− 21
Total Supply	62.6	64.0	60.8	96.9	−37	249.8	279.3	− 11
Ending Inventory	32.3	33.1	48.8	77.0	−63	48.8	77.0	− 63
Consumption	30.3	30.9	12.0	19.9	−40	201.0	202.3	− 1

Table 4.—Prices of blocks and slabs, July 1973.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
		- - - - - - - - - - Cents Per Pound - - - - - - - - - -							
Cod	1972	46.5	47.0	47.0	47.0	45.6	46.5	47.0	47.0
	1973	48.6	52.4	56.6	58.5	61.1	66.7	68.9	
Flounder	1972	43.5	44.4	45.3	49.2	51.7	53.3	55.6	57.0
	1973	59.5	59.6	60.0	60.0	60.0	62.0	63.0	
Haddock	1972	47.1	47.5	47.5	47.9	50.3	52.8	54.4	57.0
	1973	60.2	60.5	61.4	63.3	64.9	69.0	73.3	
Ocean perch	1972	38.5	38.5	38.7	39.5	39.5	39.8	41.6	45.0
	1973	51.2	53.1	53.9	54.0	54.8	53.9	54.0	
Pollock	1972	32.3	32.0	32.0	32.1	31.2	31.5	31.5	31.0
	1973	29.0	30.1	33.0	34.0	35.2	39.8	43.1	
Whiting	1972	33.0	33.5	33.0	33.0	33.2	31.5	31.5	31.5
	1973	34.6	35.8	37.5	3.75	37.5	39.4	41.1	
Wolffish	1972	49.3	50.0	50.0	50.0	50.3	50.5	51.0	51.5
	1973	51.0	50.0	54.5	52.0	52.0	52.0	52.0	

Table 5.—Supplies of fish sticks and portions, July 1973.

	MAY 1973	JUNE 1973	JULY 1973	JULY 1972	Percent Change	JAN — JULY 1973	JAN — JULY 1972	rcent ange
	- - - Million Pounds - - -				Percent	Million Pounds		Percent
Beginning Inventory	24.3	27.5	31.6	24.8	+27	34.4	23.2	+48
Production:								
Sticks	10.9	8.6	N.A.	5.2	—	N.A.	64.1	—
Portions	26.1	22.5	N.A.	12.8	—	N.A.	147.9	—
Total	37.0	31.1	N.A.	18.0	—	N.A.	212.0	—
Imports	0.2	0.2	0.1	0.1	—	1.0	0.9	+11
Total Supply	61.5	58.8	N.A.	42.9	—	N.A.	212.9	—
Ending Inventory	27.5	31.6	28.2	21.7	+30	28.2	21.7	+30
Consumption	34.0	27.2	N.A.	21.2	—	N.A.	191.2	—

Table 6.—Prices of fish sticks and portions, July 1973.

	MAY 1973	JUNE 1973	JULY 1973	JULY 1972	Percent Change	JAN — JULY 1973	JAN — JULY 1972	Percent Change
	- Cents Per Pound - - - - - - - - - - - - - - -							
Wholesale[1]								
Cod portions	67.0	67.0	67.0	60.5	+11	65.2	58.9	+11
Haddock	69.5	69.5	72.0	65.0	+11	69.6	63.6	+ 9
Cod sticks	78.0	78.0	87.0	77.0	+13	79.3	75.1	+ 6
Haddock sticks	80.0	80.0	80.0	79.2	+ 1	80.0	77.3	+ 3

[1] Weekly average prices.

plies becoming short, prices have risen rapidly. Prices at all levels were well above the previous year; as much as 67 percent higher for 51-65 count shrimp at dockside. The rise in prices this year has apparently met some resistance. Sales of shrimp were off 20 percent during July and three percent for the January-July period.

SCALLOPS

Based on doubled beginning inventories, supplies of sea scallops (Table 13) in July were 55 percent above the same month in 1972. Landings were up somewhat during the month, but that gain was more than nullified by a 12 percent drop in imports. Although prices at all levels have been declining in recent months, retail prices in July (Table 14) were well above the previous year; a marked difference from ex-vessel and wholesale prices which were 28 and 25 percent below the previous year, respectively. As a result, sales have not improved over those in 1972, and inventories continued to seasonally build.

Table 7.—Cod supplies (fillet weight, in million pounds), July 1973.

	MAY 1973	JUNE 1973	JULY 1973	JULY 1972	Percent Change	JAN — JULY 1973	JAN — JULY 1972	Percent Change
	Million Pounds				Percent	Million Pounds		Percent
Beginning Inventory	13.3	14.7	15.7	9.2	+71	16.2	6.1	+166
Landings, Total	1.8	1.5	1.0	1.1	− 9	8.5	8.5	—
Imports	6.4	9.4	5.8	10.7	−46	54.5	63.8	− 15
Total Supply	21.5	25.6	22.5	21.0	+ 7	79.2	78.4	+ 1
Ending Inventory	14.7	15.7	14.7	13.7	+ 7	14.7	13.7	+ 7
Consumption	6.8	9.9	7.8	7.3	+ 7	64.5	64.7	—

Table 8.—Flounder supplies (fillet weight, in million pounds), July 1973.

	MAY 1973	JUNE 1973	JULY 1973	JULY 1972	Percent Change	JAN — JULY 1973	JAN — JULY 1972	Percent Change
	Million Pounds				Percent	Million Pounds		Percent
Beginning Inventory	5.2	6.0	8.4	3.0	+180	8.6	9.3	− 8
Landings, Total	2.9	2.9	2.1	2.6	− 19	16.4	17.4	− 6
Imports	7.3	11.0	6.6	5.5	+ 20	53.7	35.0	+ 53
Total Supply	15.4	19.9	17.1	11.1	+ 54	78.7	61.7	+ 28
Ending Inventory	6.0	8.4	9.6	3.5	+174	9.6	3.5	+174
Consumption	9.4	11.5	7.5	7.6	− 1	69.1	58.2	+ 19

Table 9.—Haddock supplies (fillet weight, in million pounds), July 1973.

	MAY 1973	JUNE 1973	JULY 1973	JULY 1972	Percent Change	JAN — JULY 1973	JAN — JULY 1972	Percent Change
	Million Pounds				Percent	Million Pounds		Percent
Beginning Inventory	8.4	8.3	8.3	2.1	+295	9.8	8.9	+ 10
Landings, Total	0.3	0.5	0.3	0.4	− 25	2.1	2.7	− 22
Imports	3.6	4.0	3.3	3.3	—	24.6	17.2	+ 43
Total Supply	12.3	12.8	11.9	5.8	+105	36.5	28.8	+ 27
Ending Inventory	8.3	8.3	8.8	3.5	+151	8.8	3.5	+151
Consumption	4.0	4.5	3.1	2.3	+ 35	27.7	25.3	+ 9

Table 10.—Ocean perch supplies (fillet weight, in million pounds), July 1973.

	MAY 1973	JUNE 1973	JULY 1973	JULY 1972	Percent Change	JAN — JULY 1973	JAN — JULY 1972	Percent Change
	Million Pounds				Percent	Million Pounds		Percent
Beginning Inventory	4.2	5.5	10.2	3.5	+191	17.8	20.7	− 14
Landings, Total	1.7	1.8	1.2	2.1	− 43	10.9	12.4	− 12
Imports	8.1	9.5	10.2	6.1	+ 67	41.3	30.0	+ 38
Total Supply	14.0	16.8	21.6	11.7	+ 85	70.0	63.1	+ 11
Ending Inventory	5.5	10.2	14.4	6.3	+129	14.4	6.3	+129
Consumption	8.5	6.6	7.2	5.4	+ 33	55.6	56.8	− 2

AMERICAN LOBSTER

Both Maine landings and imports of American lobsters were well below the previous year during the month (Table 15). Maine landings were very good during the first half of 1973 (up 57 percent); however, they slumped by 11 percent in July. This may have been the result of the start of the shedding season, a period in which the lobsters are relatively inactive.

As in June, July imports from Canada were again below the previous year. Total shipments received during the month were off a fourth from 1972, causing the quantity received during January-July to be down 12 percent. The recent declines can partially be attributed to the low wholesale prices (Table 16) during the year —off 7 to 12 percent during the month. In light of a slight rise in Canadian landings during the first half of the year, some supplies may have been withheld from the U.S. market because of the lower 1973 prices.

SPINY LOBSTER TAILS

Supplies of spiny lobsters on the U.S. market (Table 17) continue to be below the previous year as imports were again off. Imports were down 20 percent with the Republic of South Africa, usually a leading supplier, recording no shipments during the month. Local regulation of the resource and marketing of spiny lobsters in that country is apparently further limiting its ability to supply the United States.

Table 11.—Shrimp supplies, July 1973.

	MAY 1973	JUNE 1973	JULY 1973	JULY 1972	Percent Change	JAN-JUN 1973	JAN-JUN 1972	Percent Change
	- - - - - - - Million Pounds - - - - - -				Percent	Million Pounds		Percent
Beginning Inventory	58.2	54.2	50.6	64.1	−21	92.7	69.9	+ 33
Landings								
Total	14.0	27.8	25.7	34.7	−26	108.3	123.8	− 12
Gulf	8.0	17.5	14.5	20.2	−28	57.6	74.1	− 22
Northeast	.7	1.0	.6	.6	—	10.4	12.2	− 15
Pacific	5.3	7.6	9.0	12.0	−25	36.5	32.2	+ 13
South Atlantic		1.7	1.6	1.9	−16	3.8	5.3	− 28
Imports	16.4	15.4	17.0	23.6	−28	117.3	142.7	− 18
Total Supply	88.6	97.4	93.3	122.4	−24	318.3	336.4	− 5
Ending Inventory	54.2	50.6	51.5	69.2	−26	51.5	69.2	− 26
Exports								
Total	4.2	4.5	3.1	3.0	+ 3	32.2	22.1	+ 46
Domestic Fresh & Frozen	3.1	2.7	2.7	2.2	+22	23.6	18.3	+ 29
Transshipments	1.1	1.8	.4	.8	−50	8.6	3.8	+126
Gulf Canned Pack	1.8	8.0	2.2	5.1	−57	12.8	17.1	− 25
Fresh & Frozen								
Consumption	28.4	34.3	36.5	45.1	−20	221.8	228.0	− 3

Table 13.—Scallop supplies, July 1973.

	MAY 1973	JUNE 1973	JULY 1973	JULY 1972	Percent Change	JAN-JULY 1973	JAN-JULY 1972	Percent Change
	- - - - - - Thousand Pounds - - - - -				Percent	Thousand Pounds		Percent
Beginning Inventory	2,954	3,001	3,159	1,012	+212	3,736	1,585	+136
Landings, Total	694	578	700	603	+ 16	4,123	3,856	+ 7
Imports	2,175	1,638	1,780	2,032	− 12	11,378	9,563	+ 19
Total Supply	5,823	5,217	5,639	3,647	+ 55	19,237	15,004	+ 28
Ending Inventory	3,001	3,159	3,429	1,408	+144	3,429	1,408	+144
Consumption	2,822	2,058	2,210	2,239	− 1	15,808	13,596	+ 16

Table 15.—American lobster supplies, July 1973.

	MAY 1973	JUNE 1973	JULY 1973	JULY 1972	Percent Change	JAN-JULY 1973	JAN-JULY 1972	Percent Change
	- - -Thousand Pounds - - -				Percent	Thousand Pounds		Percent
Maine Landings	1,280	914	1,425	1,612	−11	4,667	3,674	+27
Imports	3,517	5,309	3,267	4,322	−24	18,249	20,699	−12
Consumption	4,797	6,223	4,692	5,934	−21	22,916	24,373	− 6

Table 17.—Spiny lobster tail supplies, July 1973.

	MAY 1973	JUNE 1973	JULY 1973	JULY 1972	Percent Change	JAN-JULY 1973	JAN-JULY 1972	Percent Change
	- - - Million Pounds - - -				Percent	Million Pounds		Percent
Beginning Inventory	7.4	6.9	7.3	7.6	− 4	8.9	4.7	+89
Imports	2.6	2.9	2.0	2.5	−20	19.7	24.0	−18
Total Supply	10.0	9.8	9.3	10.1	− 8	28.6	28.7	0
Ending Inventory	6.9	7.3	6.7	8.0	−16	6.7	8.0	−16
Consumption	3.1	2.5	2.6	2.1	+24	21.9	20.7	+ 6

Wholesale prices (Table 18) continued to rise to new records during the month. At $4.88 per pound, 6 - 8 ounce cold-water lobster tails were 10 percent above the high prices set in July, 1972. A record high of $5.08 was quoted during the month for 4-6 ounce tails from Australia.

Table 12.—Shrimp prices, July 1973.

	MAY 1973	JUNE 1973	JULY 1973	JULY 1972	Percent Change
	- - - Dollars Per Pound - - -				
Ex-vessel					
15-20 count	2.14	2.12	2.24	2.01	+11
31-35	1.84	1.70	1.77	1.34	+32
51-65	1.34	1.30	1.42	.85	+67
Wholesale					
15-20 count	2.28	2.34	2.38	2.30	+ 4
31-35	1.99	2.06	1.98	1.63	+22
51-65	1.54	1.58	1.58	.96	+65
Retail					
15-25 count	3.01	2.94	2.94	2.92	+ 1
31-42	2.28	2.38	2.49	2.09	+19

Table 14.—Scallop prices, July 1973.

	MAY 1973	JUNE 1973	JULY 1973	JULY 1972	Percent Change
	- - - Dollars Per Pound - - -				
Ex-vessel	1.44	1.44	1.48	2.05	−28
Wholesale	1.82	1.64	1.63	2.18	−25
Retail	3.08	3.03	2.80	2.66	+ 5

Table 16.—American lobster prices, July 1973.

	MAY 1973	JUNE 1973	JULY 1973	JULY 1972	Percent Change
	- - - Dollars Per Pound - - -				
Ex-vessel	1.29	1.37	1.46	1.45	—
Wholesale					
2 lb.	1.92	1.97	2.16	2.32	− 7
1½	1.87	1.96	2.16	2.43	−11
1¼	1.80	1.93	2.16	2.45	−12
1⅛	1.77	1.90	2.12	2.32	− 9
chix	1.76	1.89	2.12	2.41	−12

Table 18.—Spiny lobster tail prices, July 1973.

	MAY 1973	JUNE 1973	JULY 1973	JULY 1972	Percent Change
	- - - Dollars Per Pound - - -				
Wholesale Price					
6-8 oz. tail					
Cold-water	4.71	4.83	4.88	4.42	+10
Warm-water	3.65	3.82	4.00	3.74	+ 7

Editor's comments

Past, Present, and Future Perfect

• Our papers this month deal with fishery problems past, present, and future. They range in time from the late 19th century on through the present to the 21st century. In "Fisheries Research Steamer *Fish Hawk*," John Reintjes recounts the history of a sturdy old vessel that began her career as a floating fish hatchery, designed to augment shad runs along the eastern coast of the United States. She began her mission just under a century ago. When the idea of a floating hatchery lost appeal early in this century, she was used for other forms of fishery research until she was condemned and sold in 1926. "For nearly half a century," Reintjes says, "she symbolized Federal fisheries research to fishermen and other coastal residents along the Atlantic seaboard."

In "Why the cod shortage? What are the alternatives?" Donald Whitaker addresses himself to a serious contemporary problem—dwindling supplies of cod—and suggests some solutions. In "The overland shipment of live Dungeness crab by self-contained van" H. J. Barnett and his coauthors describe research aimed at getting premium quality seafood to outlying markets. In "San Francisco Bay area's herring resource—a colorful past and a controversial future," Maxwell Eldridge and Michael Kaill tell about the efforts of the State of California, spurred by the fierce local demand of the people of San Francisco—the only people in this country with the temerity to *tear down* a freeway—to preserve and enhance a small, local fishery.

With "The technological basis for development of aquaculture to produce low-cost food fish" John Dassow and Maynard Steinberg tackle the future head-on. Their long, thoughtful, and detailed article faces up squarely to what the futurists say is a problem that we cannot dodge—supplying nutritious, inexpensive food (not specialized gourmet items) for the nourishment of our people.

There is a tense in English called "future perfect." (This is far different from a perfect future—nobody over 14 years of age believes in that.) An example of the usage of this tense would be: "By the year 2000, the world fish catch will have reached its maximum potential yield." Dassow and Steinberg cannily refuse to set a date by which their highly technological system of fish production is likely to be in use, but, informed optimists, they say it can be done. The mechanized, mass-production system they envision is a good long way from the stocking our eastern rivers with shad from the *Fish Hawk*. It probably has a better chance of success, too, for one by one, the variables that have harrassed fish production in the past seem to be disappearing, as man begins to exercise greater control.

• Speaking of the future, it is with us. Reprinted below, verbatim and without further comment, is a recent release from the NMFS Statistics and Market News:

> The Tokyo Aircraft Instruments Company has developed a $5,660 automatic fishing machine called Ultra Power Fisher that can automatically land a bonito-sized fish, unhook it, bait the hook and start fishing again in about 10 seconds. It can haul in fish weighing from 6½ to 66 pounds with equal facility. The four-unit device consists of a nine or 15-foot pole, an air compressor, a fluidic power unit and a control box. Three fishing companies have bought all 300 machines sold since they first went on the market last year and the maker now has orders to turn out 1,500 more. Installing 12 of these fishers, as most fishing boats using them have done, replaces at least 24 fishermen. When a fish takes the hook, tension sends a signal to the controller on the bridge, who presses a switch raising the pole over a 110-degree arc and then pushes another button releasing the fish onto the deck below. The pole is then brought back the full 180 degrees and the hook automatically picks up sardine bait spread there. The hook is a device that is thrust into the mouth of the fish snapping at the bait, jams open its jaws holding the fish by tension and then returns to normal when the pole is over the deck, breaking the tension and dropping the fish onto the deck below.

• I spent five years in Hawaii. There I learned to like Japanese food very much. With one exception. Every time you ordered sushi (fish, usually raw, on little rice patties), you got one that was topped by a slab of semi-transparent, textureless white squid. To me, eating one was about as rewarding as trying to chew your way through the sole of a tennis shoe. As a result, I have always looked askance at those who insist that squid is one of the great fisheries of the future. (A recent FAO publication, written by Gilbert L. Voss of the School of Marine and Atmospheric Science, University of Miami, estimates the potential of the continental shelf fisheries of the cephalopods, of which the squid is one, at over 7 million metric tons, the oceanic potential at several times that figure.) A recent trip to San Diego, however, has converted me. Squid need not be, as the non-Swedish wife of a Swedish friend of mine once described lutefisk to me, "a gelatinous mess." In San Diego I had "squid cutlets." These were sections of squid deep-fried in a garlicky batter and they were delectable. The plate was garnished with tiny octopuses, also deep-fried. So the future, when we all eat squid and comminuted white amur fish sticks, may not be perfect, but not so bad after all. T.A.M.

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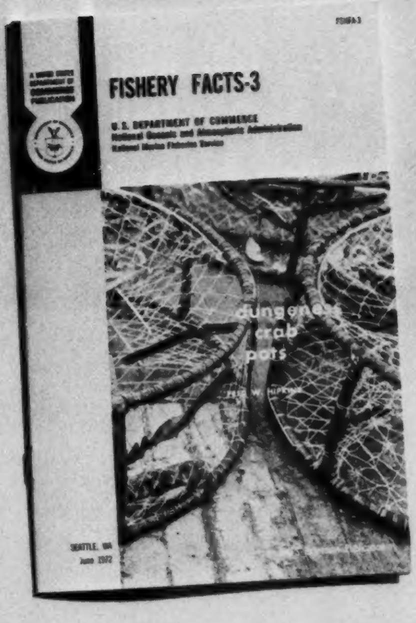

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